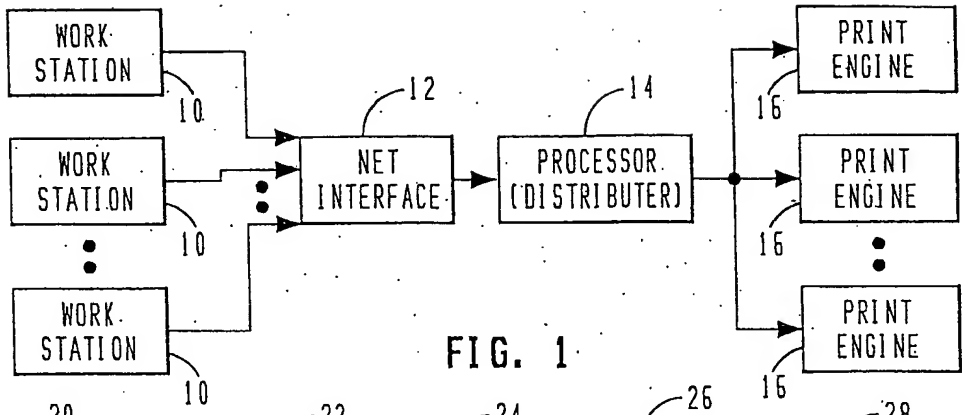
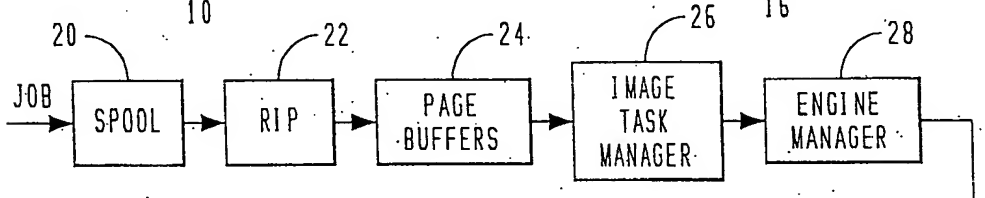


FIG. 1



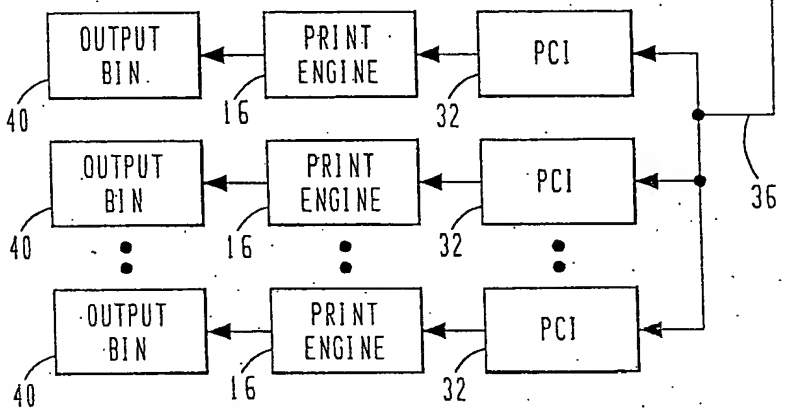


FIG. 2

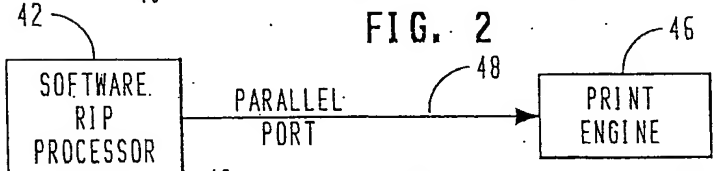


FIG. 3a

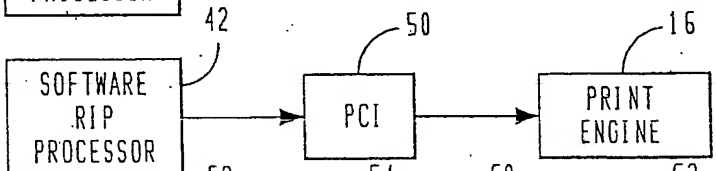


FIG. 3b

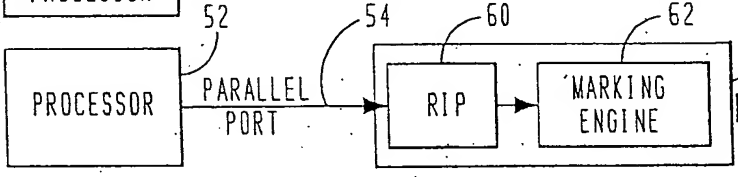


FIG. 3c

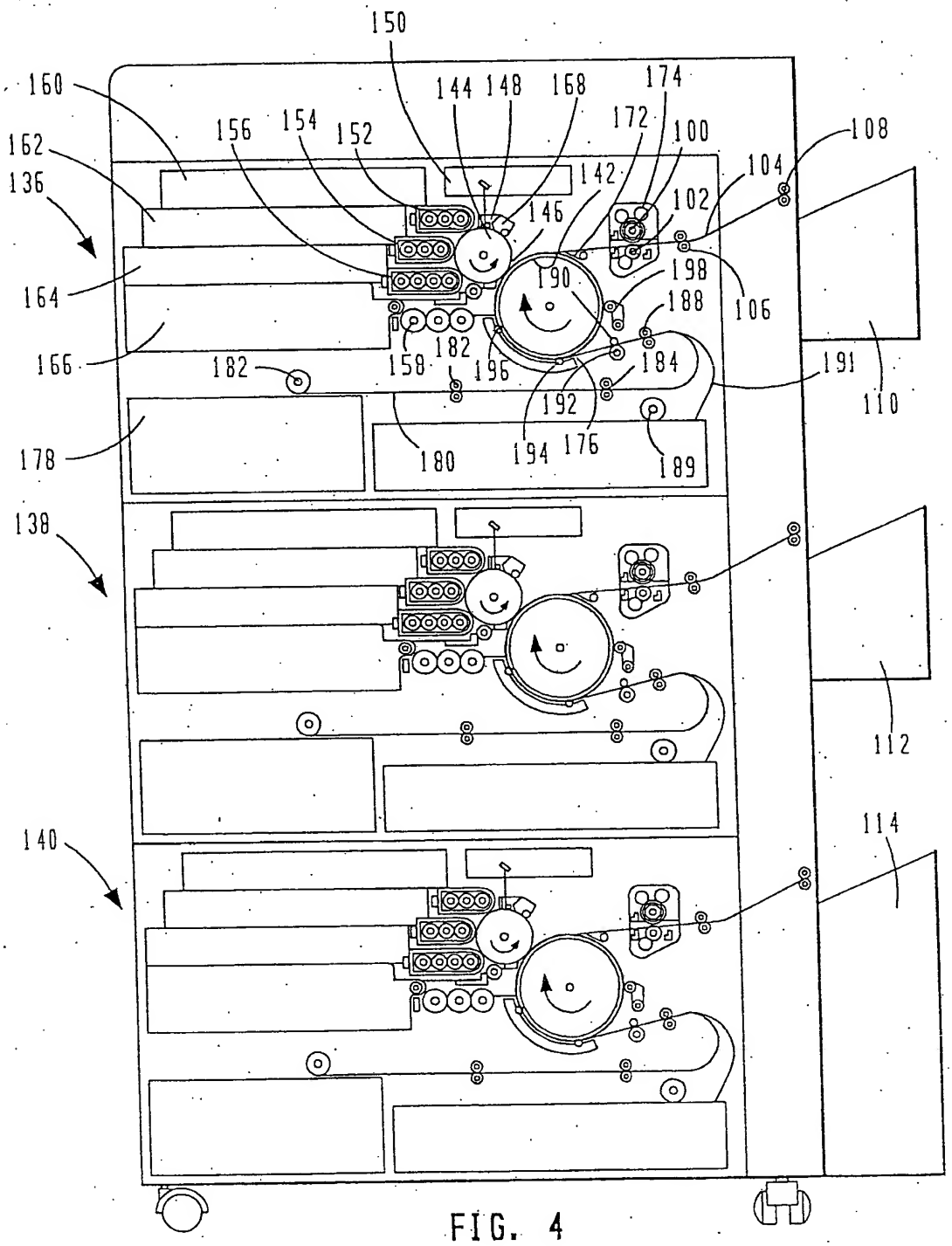

150
160
144
148
168
174
156
154
152
172
100
108
162
142
104
136
146
102
164
190
198
106
188
166
182
158
182
196
184
191
192
110
178
180
194
176
189
138
112
140
114

FIG. 4

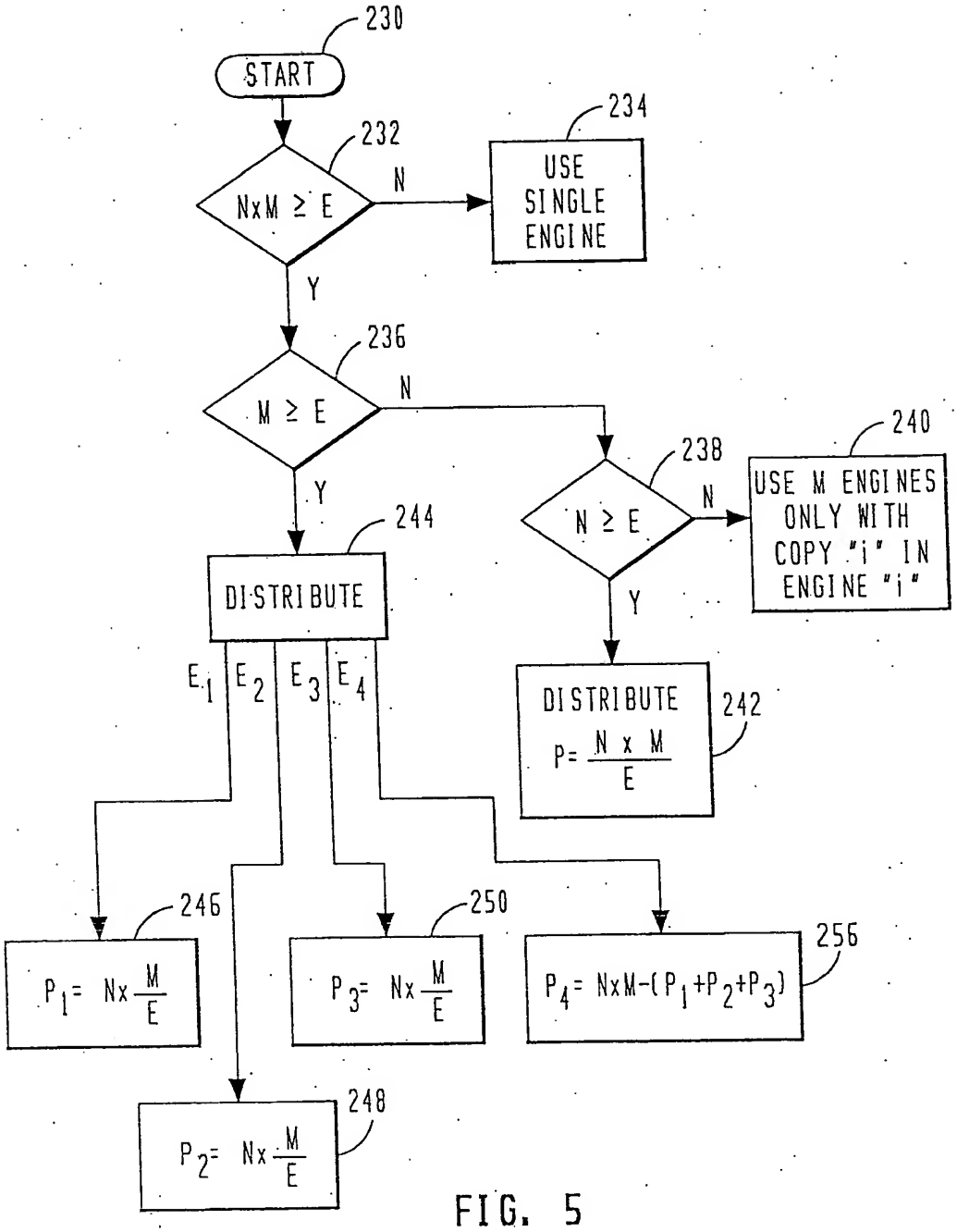

230
START
232
NxM ≥ E
N
234
USE SINGLE ENGINE
Y
236
M ≥ E
N
238
N ≥ E
N
240
USE M ENGINES ONLY WITH COPY "i" IN ENGINE "i"
Y
244
DISTRIBUTE
Y
DISTRIBUTE P= N x M / E
242
E1 E2 E3 E4
246
P1= Nx M/E
248
P2= Nx M/E
250
P3= Nx M/E
256
P4= NxM-(P1+P2+P3)

FIG. 5

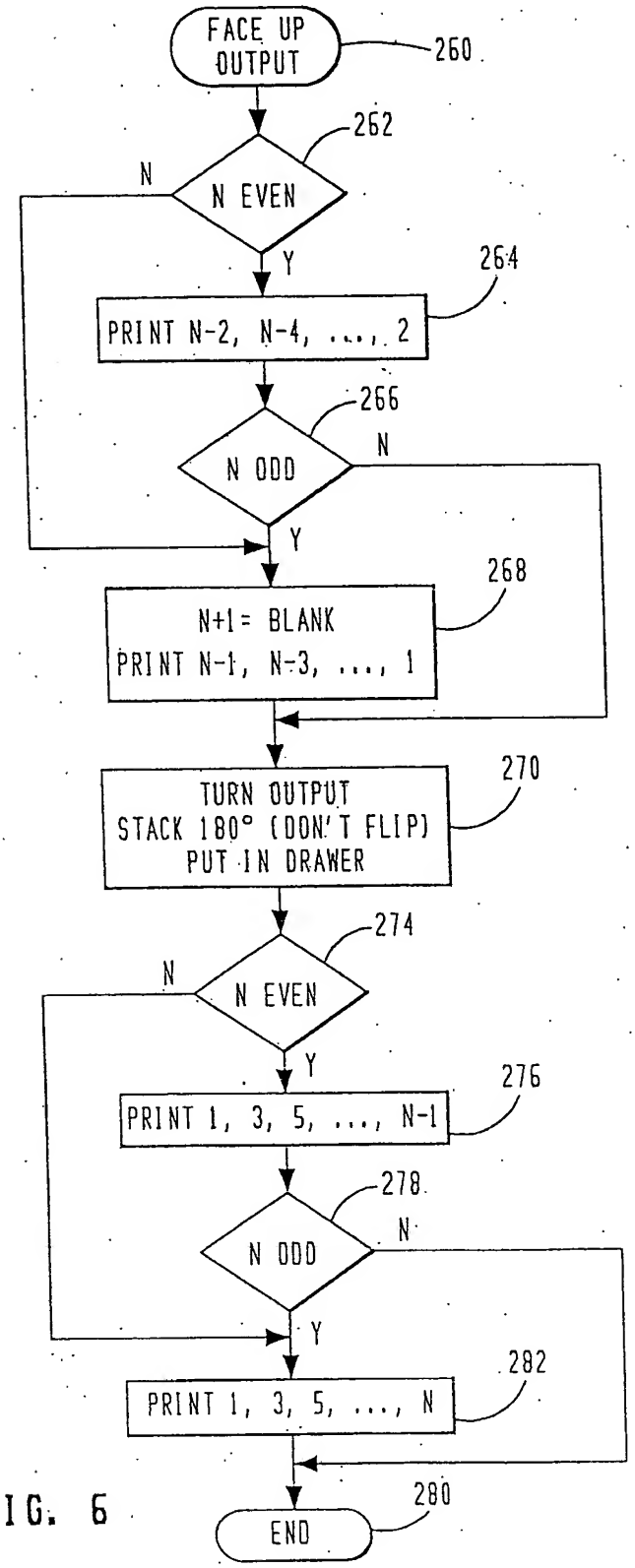

FACE UP OUTPUT
260
262
N EVEN
N
Y
264
PRINT N-2, N-4, ..., 2
266
N ODD
N
Y
268
N+1 = BLANK
PRINT N-1, N-3, ..., 1
270
TURN OUTPUT STACK 180° (DON'T FLIP) PUT IN DRAWER
274
N EVEN
N
Y
276
PRINT 1, 3, 5, ..., N-1
278
N ODD
N
Y
282
PRINT 1, 3, 5, ..., N
280
END

FIG. 6

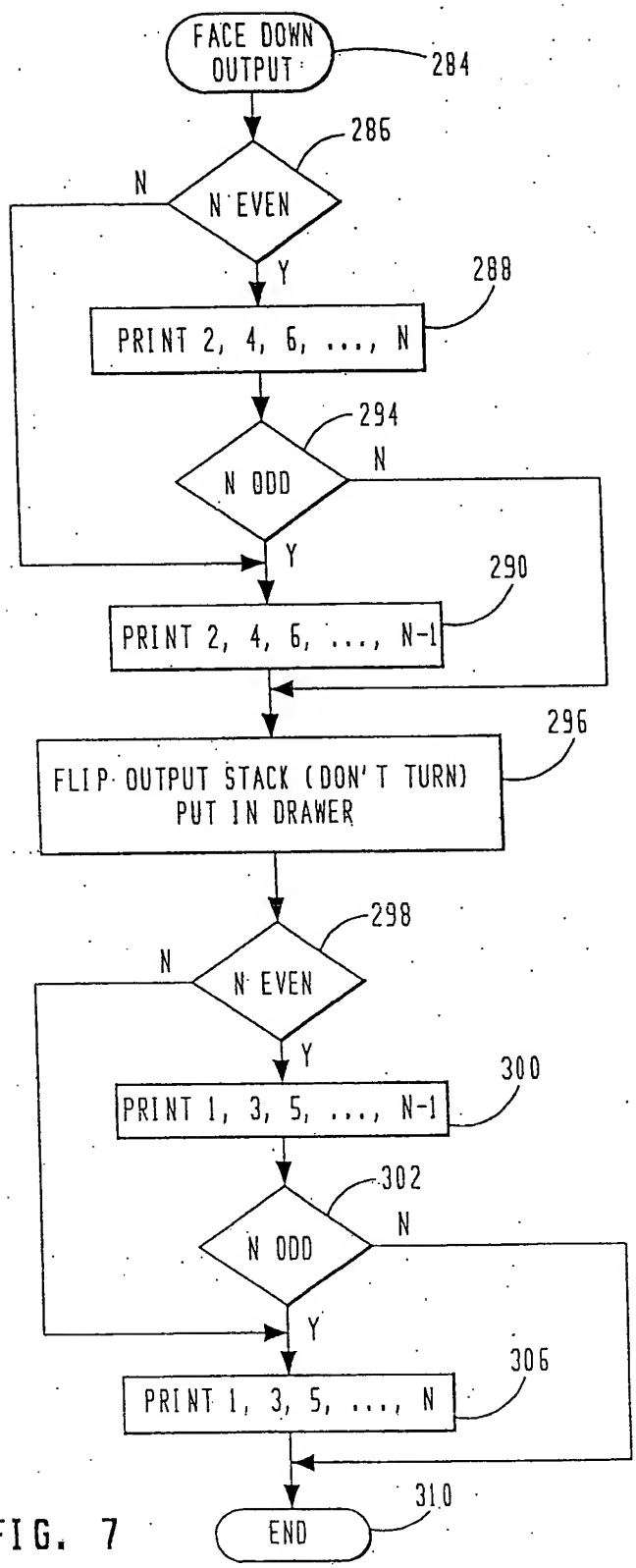

FACE DOWN OUTPUT
284
286
N EVEN
N
Y
288
PRINT 2, 4, 6, ..., N
294
N ODD
N
Y
290
PRINT 2, 4, 6, ..., N-1
296
FLIP OUTPUT STACK (DON'T TURN)
PUT IN DRAWER
298
N EVEN
N
Y
300
PRINT 1, 3, 5, ..., N-1
302
N ODD
N
Y
306
PRINT 1, 3, 5, ..., N
310
END

FIG. 7

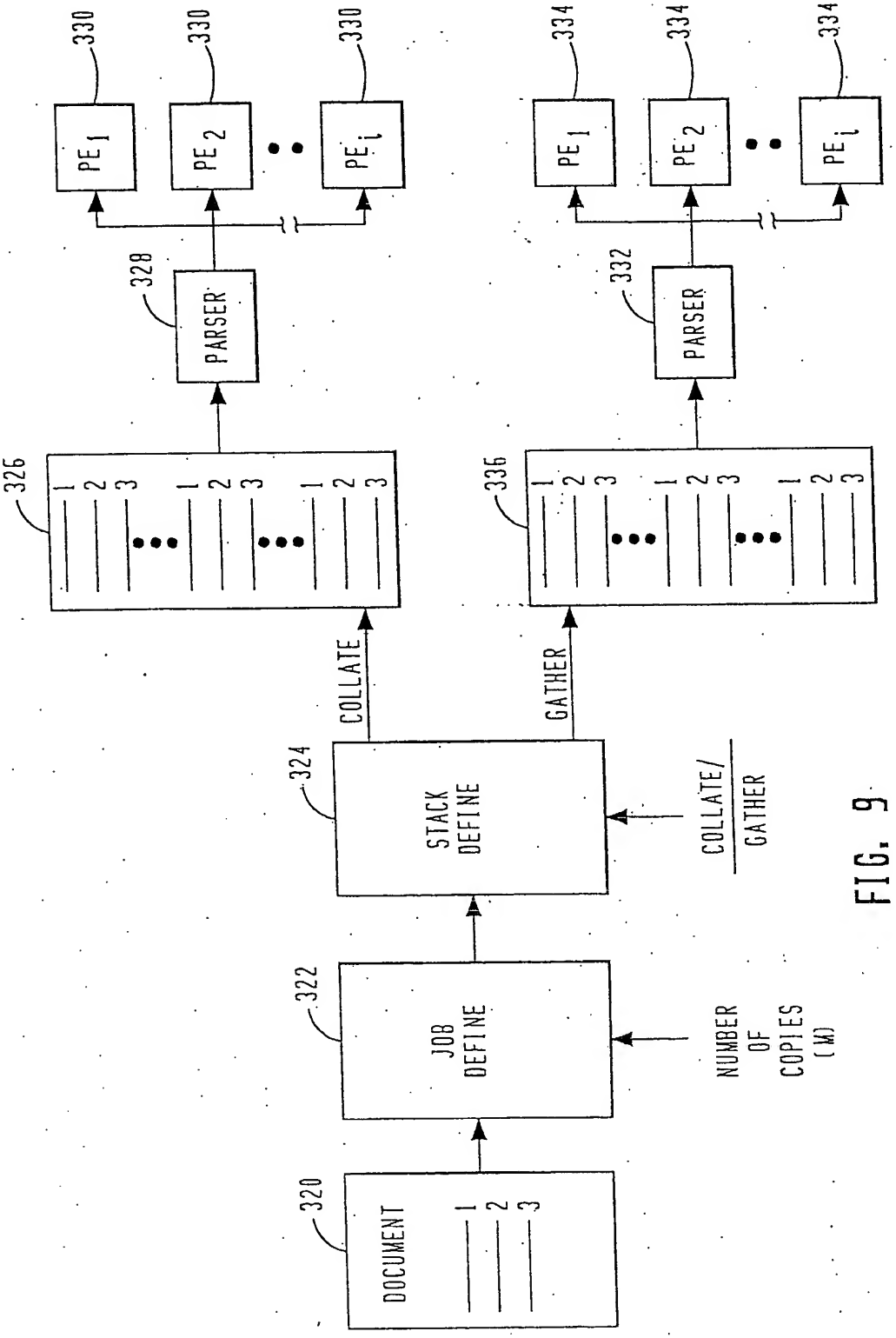

320
DOCUMENT
1
2
3
322
JOB DEFINE
NUMBER OF COPIES (M)
324
STACK DEFINE
COLLATE/ GATHER
COLLATE
GATHER
326
336
328
332
PARSER
PARSER
330
334
PE 1
PE 2
PE i

FIG. 9

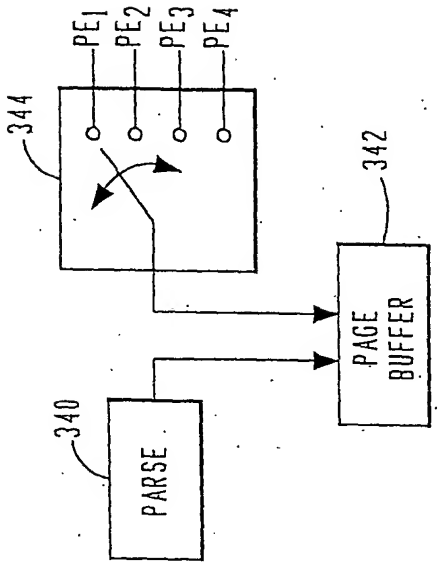


FIG. 11

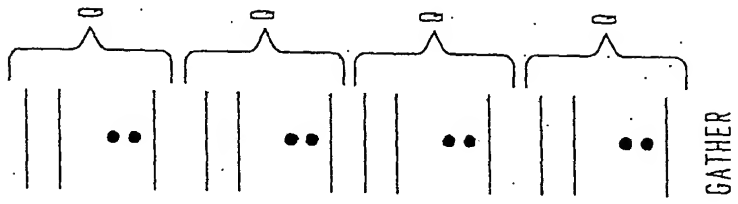


FIG. 10

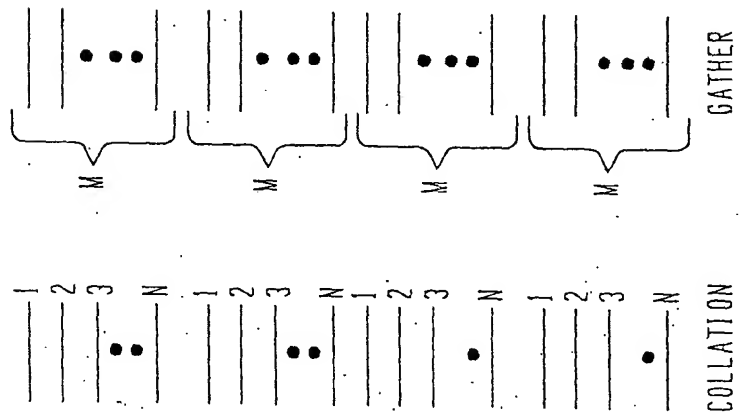


FIG. 8

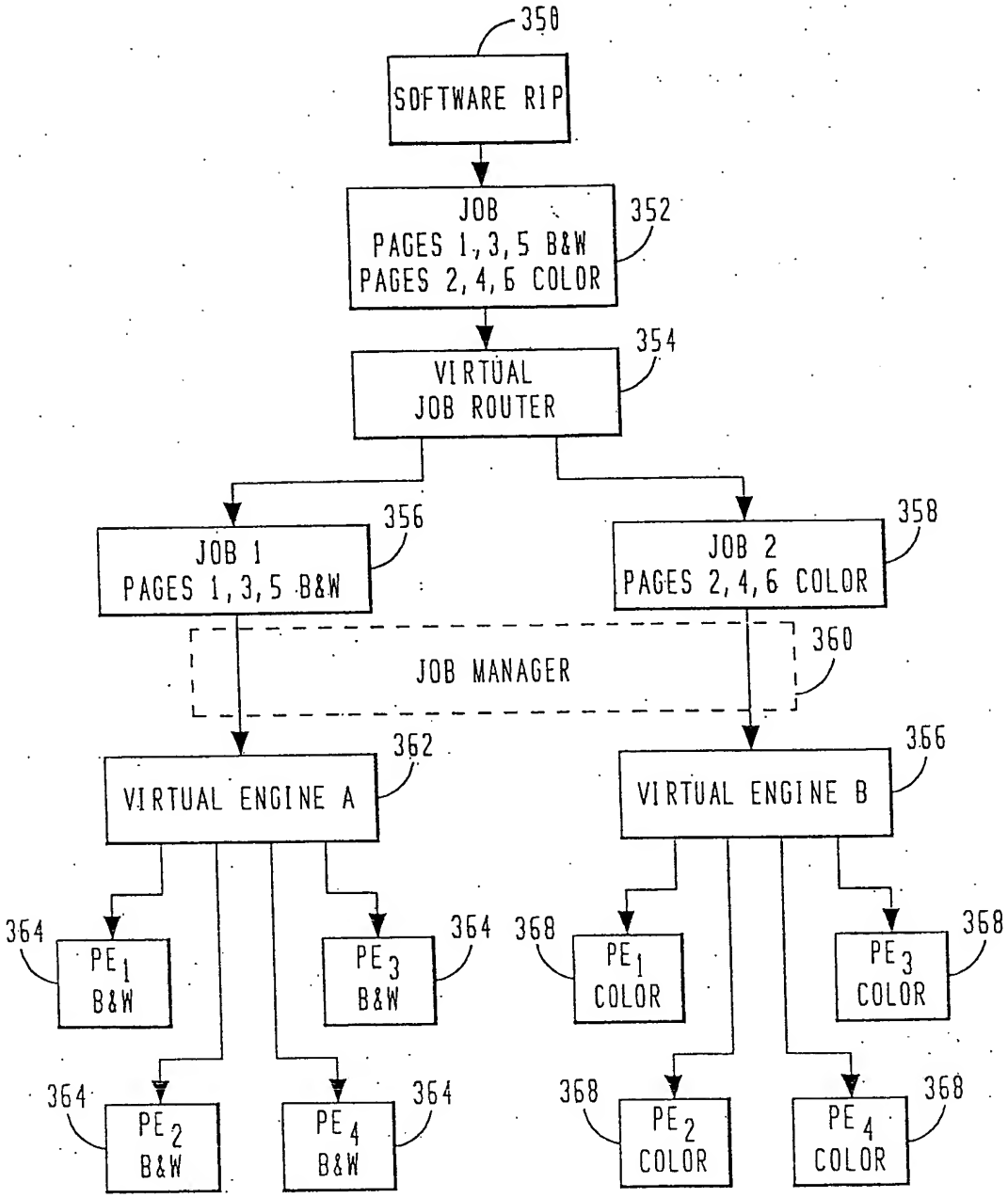

350
SOFTWARE RIP
JOB
PAGES 1,3,5 B&W
PAGES 2,4,6 COLOR
352
VIRTUAL
JOB ROUTER
354
JOB 1
PAGES 1,3,5 B&W
356
JOB 2
PAGES 2,4,6 COLOR
358
JOB MANAGER
360
VIRTUAL ENGINE A
362
VIRTUAL ENGINE B
366
PE1 B&W
PE3 B&W
PE2 B&W
PE4 B&W
364
PE1 COLOR
PE3 COLOR
PE2 COLOR
PE4 COLOR
368

FIG. 12

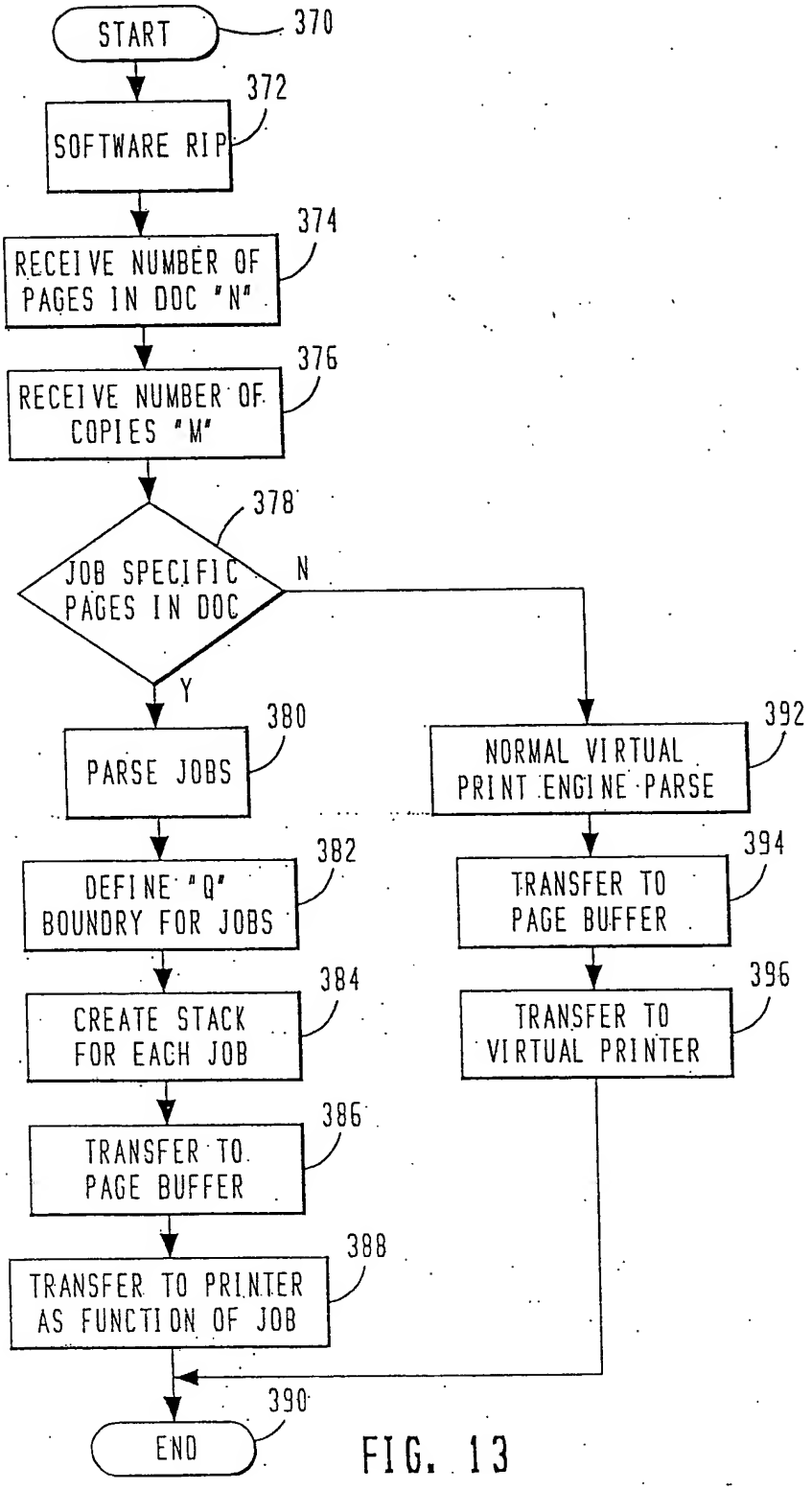

START
370
SOFTWARE RIP
372
RECEIVE NUMBER OF PAGES IN DOC "N"
374
RECEIVE NUMBER OF COPIES "M"
376
JOB SPECIFIC PAGES IN DOC
378
N
Y
PARSE JOBS
380
DEFINE "Q" BOUNDRY FOR JOBS
382
CREATE STACK FOR EACH JOB
384
TRANSFER TO PAGE BUFFER
386
TRANSFER TO PRINTER AS FUNCTION OF JOB
388
NORMAL VIRTUAL PRINT ENGINE PARSE
392
TRANSFER TO PAGE BUFFER
394
TRANSFER TO VIRTUAL PRINTER
396
END
390

FIG. 13

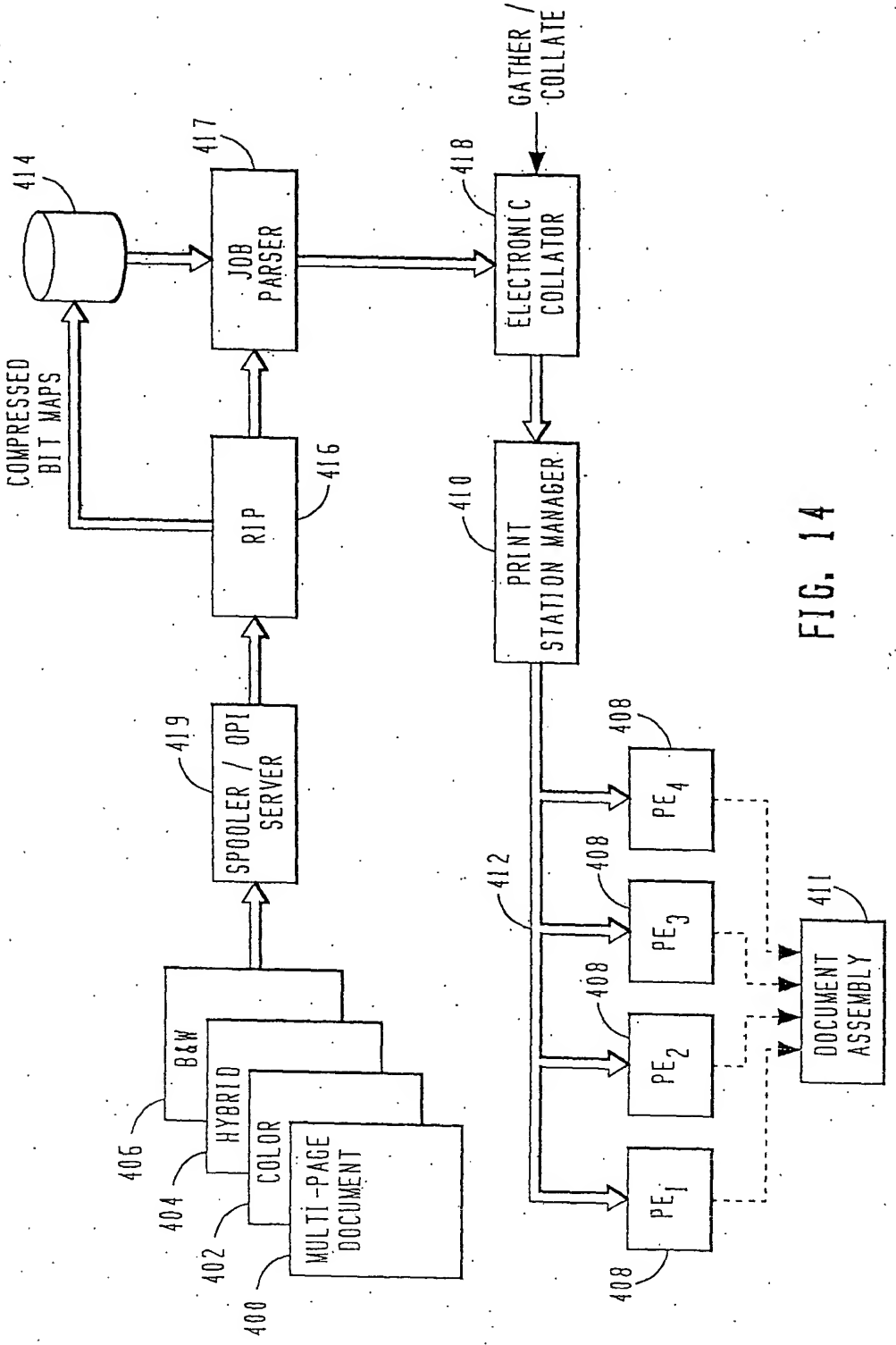

MULTI-PAGE DOCUMENT
COLOR
HYBRID
B&W
400
402
404
406
SPOOLER / OPI SERVER
419
RIP
416
COMPRESSED BIT MAPS
414
JOB PARSER
417
ELECTRONIC COLLATOR
418
GATHER / COLLATE
PRINT STATION MANAGER
410
412
PE1
PE2
PE3
PE4
408
DOCUMENT ASSEMBLY
411

FIG. 14

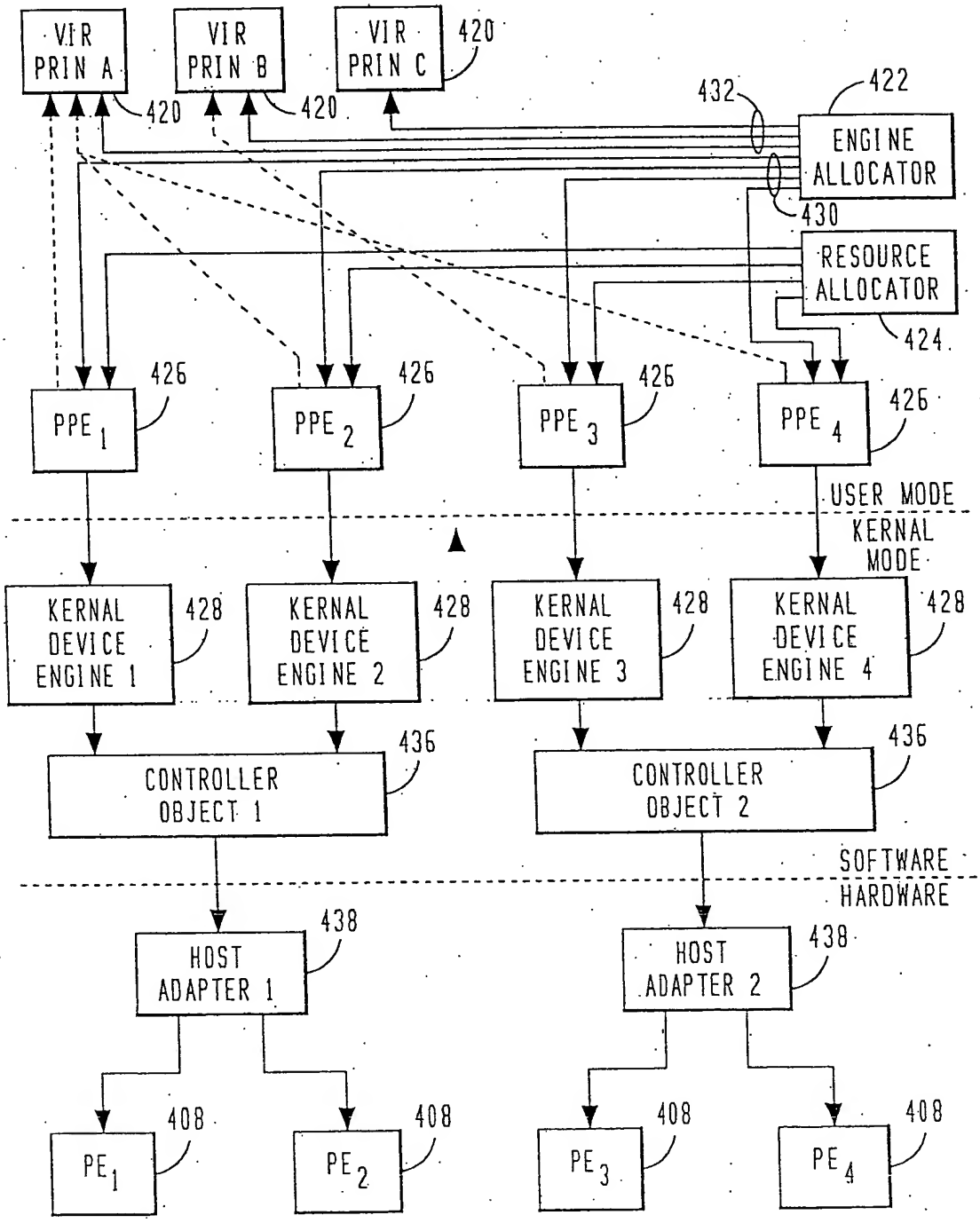

VIR PRIN A
VIR PRIN B
VIR PRIN C
420
420
420
432
422
ENGINE ALLOCATOR
430
RESOURCE ALLOCATOR
424
426
PPE 1
PPE 2
PPE 3
PPE 4
USER MODE
KERNAL MODE
KERNAL DEVICE ENGINE 1
KERNAL DEVICE ENGINE 2
KERNAL DEVICE ENGINE 3
KERNAL DEVICE ENGINE 4
428
CONTROLLER OBJECT 1
CONTROLLER OBJECT 2
436
SOFTWARE
HARDWARE
HOST ADAPTER 1
HOST ADAPTER 2
438
PE 1
PE 2
PE 3
PE 4
408

FIG. 15

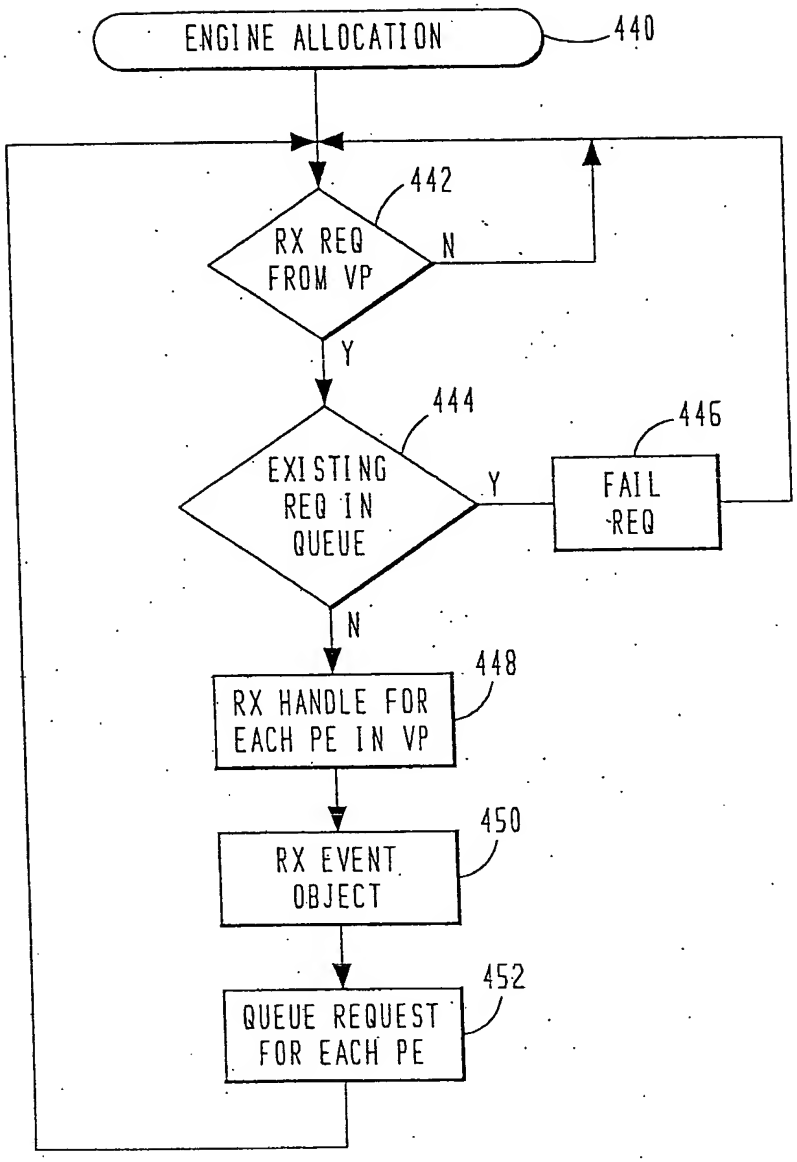

ENGINE ALLOCATION
440
442
RX REQ FROM VP
N
Y
444
EXISTING REQ IN QUEUE
Y
446
FAIL REQ
N
448
RX HANDLE FOR EACH PE IN VP
450
RX EVENT OBJECT
452
QUEUE REQUEST FOR EACH PE

FIG. 16

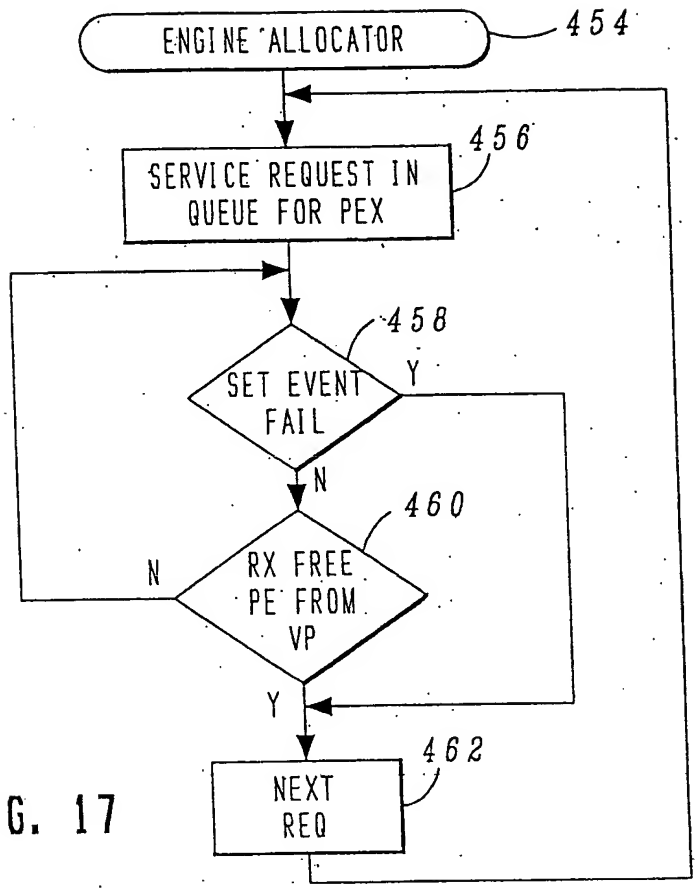

ENGINE ALLOCATOR
454
SERVICE REQUEST IN QUEUE FOR PEX
456
458
SET EVENT FAIL
Y
N
460
RX FREE PE FROM VP
N
Y
462
NEXT REQ

FIG. 17

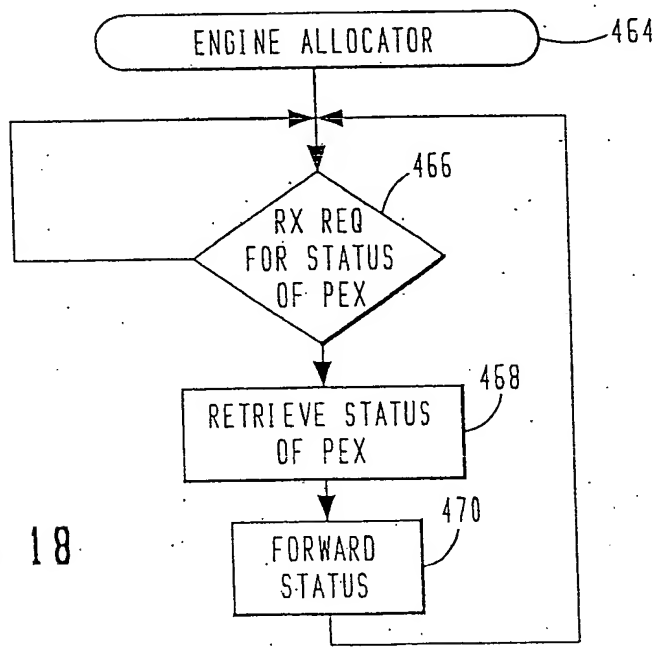

ENGINE ALLOCATOR
464
466
RX REQ FOR STATUS OF PEX
468
RETRIEVE STATUS OF PEX
470
FORWARD STATUS

FIG. 18

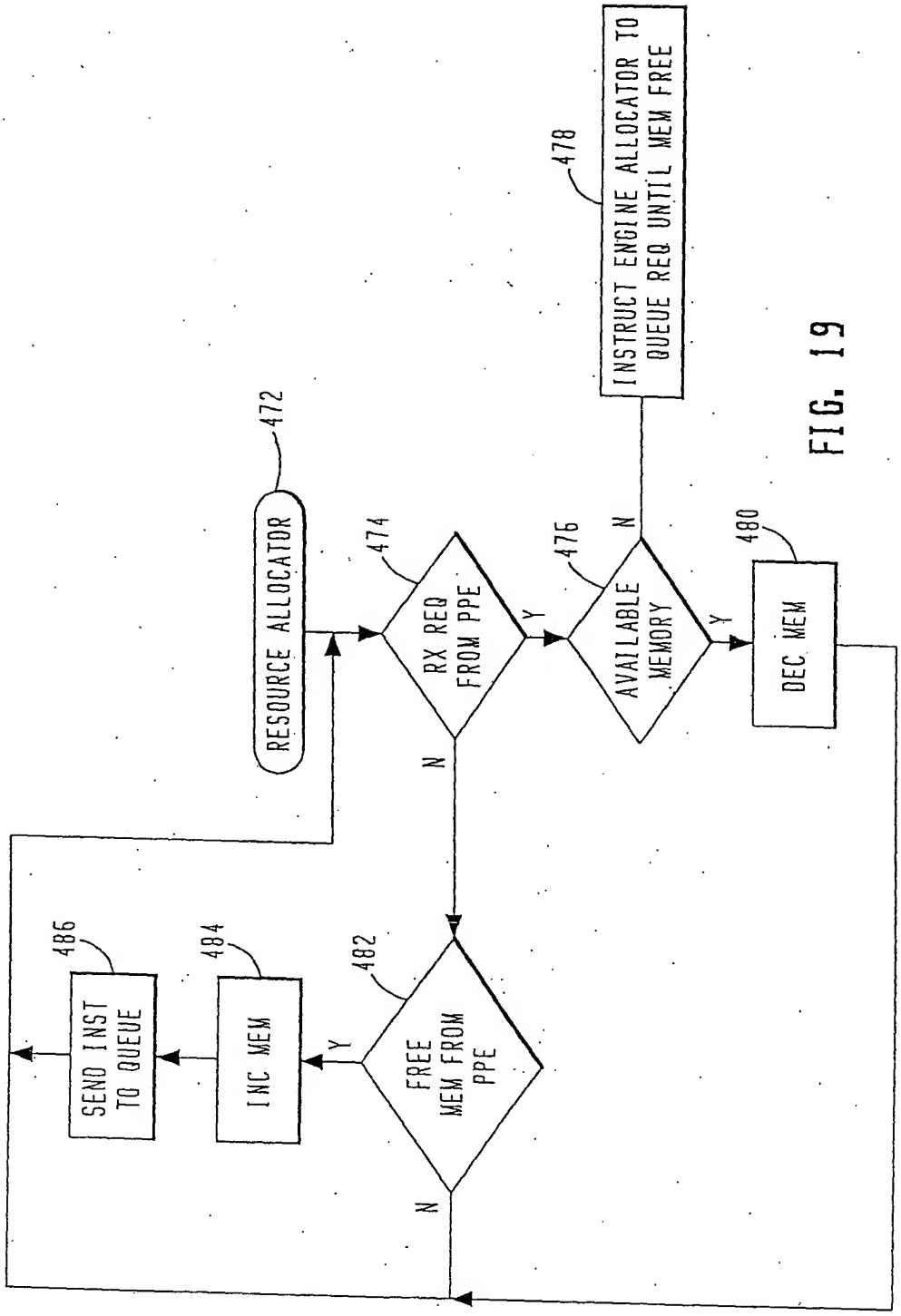

RESOURCE ALLOCATOR
472
RX REQ FROM PPE
474
AVAILABLE MEMORY
476
INSTRUCT ENGINE ALLOCATOR TO QUEUE REQ UNTIL MEM FREE
478
DEC MEM
480
FREE MEM FROM PPE
482
INC MEM
484
SEND INST TO QUEUE
486
Y
N
Y
N
Y
N

FIG. 19

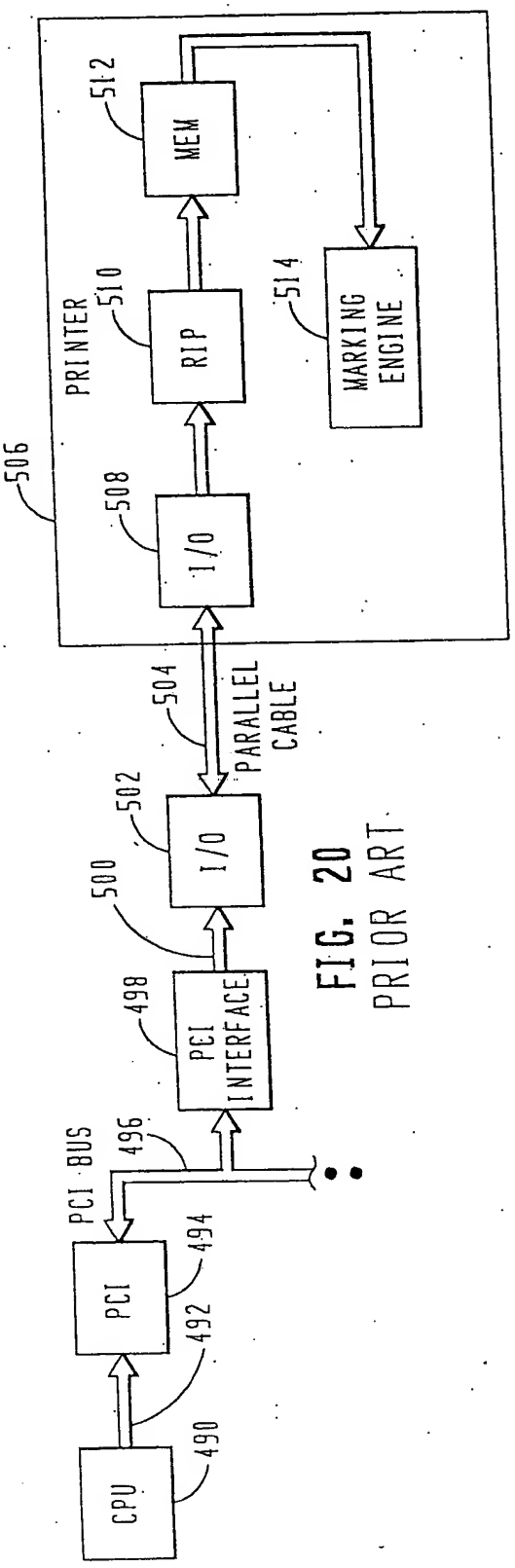


FIG. 20
PRIOR ART

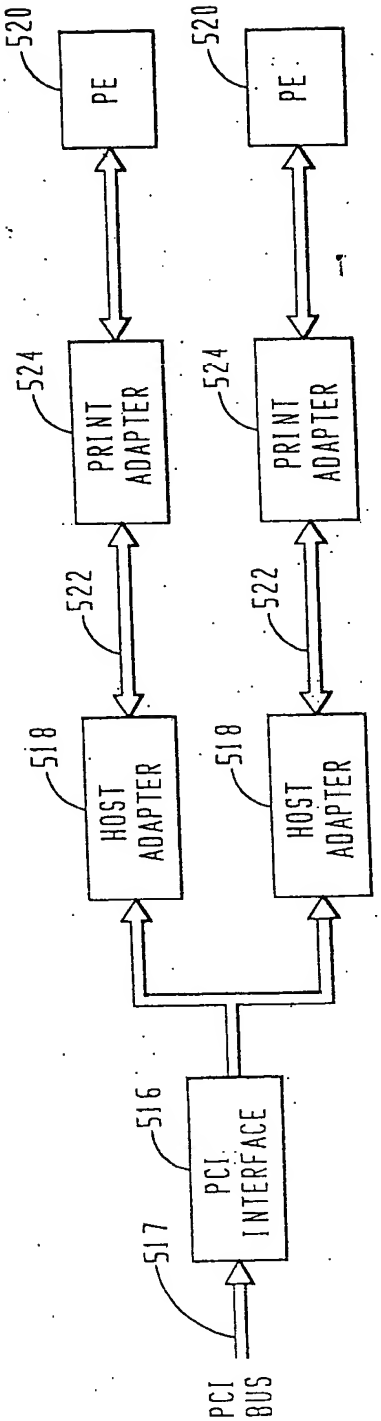


FIG. 21

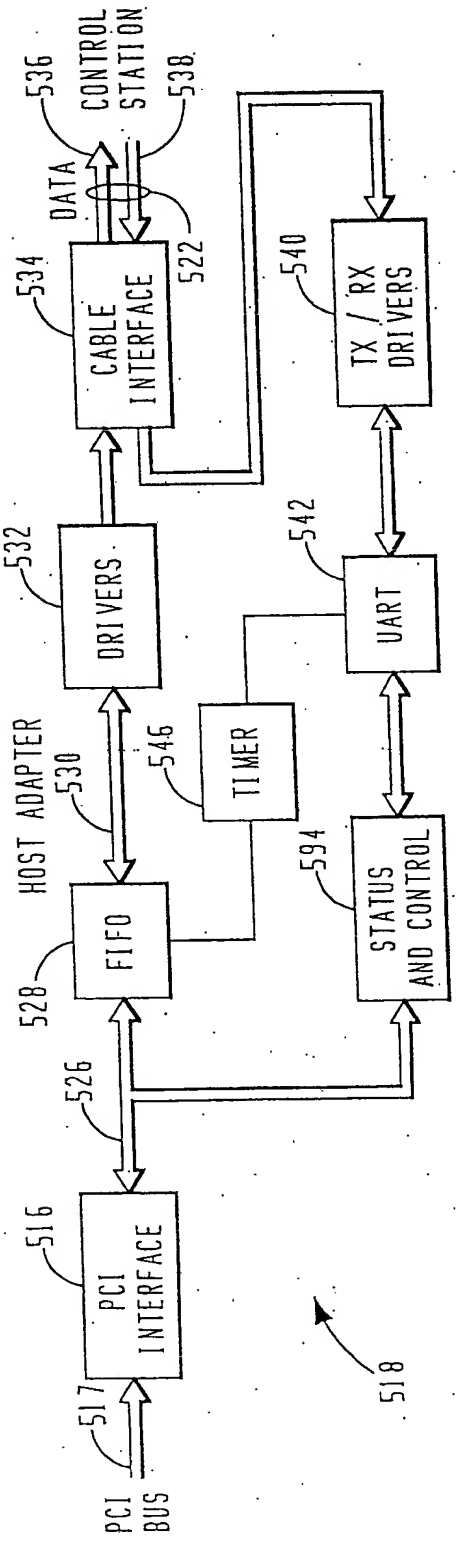

536
CONTROL STATION
538
DATA
534
CABLE INTERFACE
522
540
TX / RX DRIVERS
532
DRIVERS
542
UART
HOST ADAPTER
530
546
TIMER
528
FIFO
594
STATUS AND CONTROL
526
516
PCI INTERFACE
517
PCI BUS
518

FIG. 22

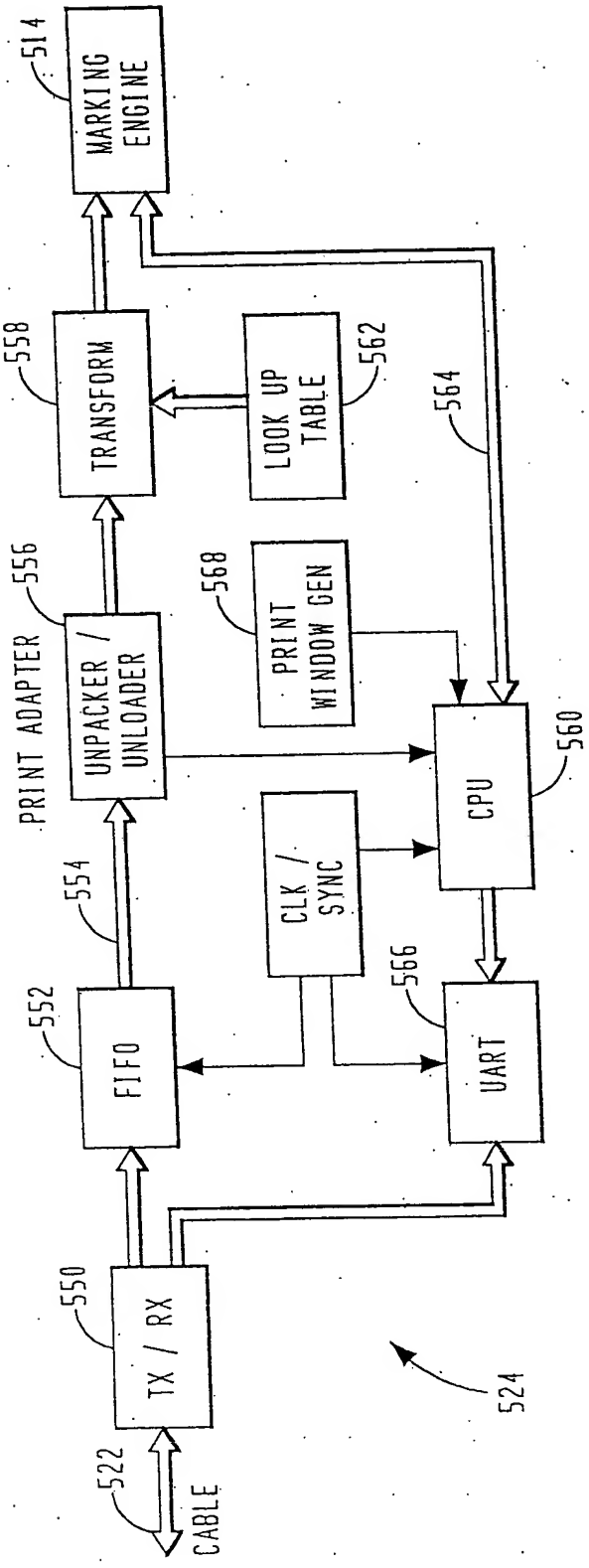


FIG. 23

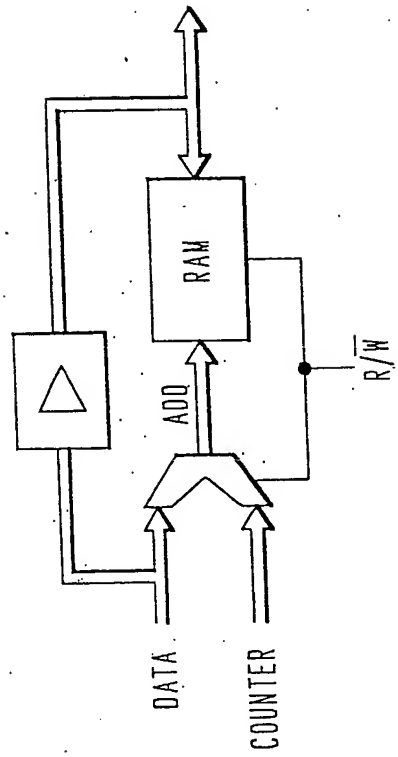


FIG. 23a

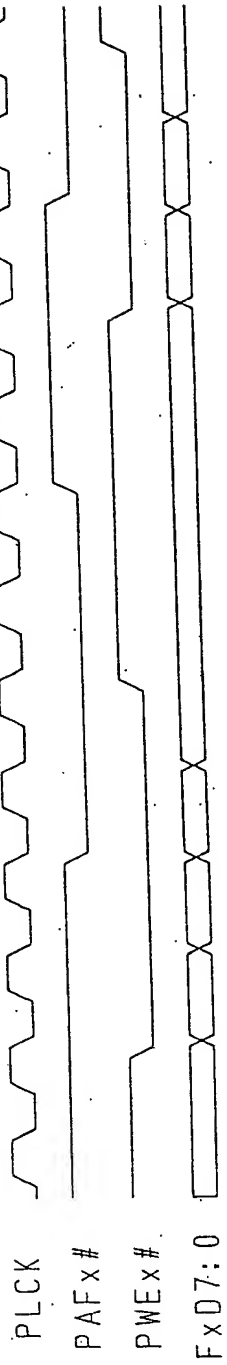


FIG. 24

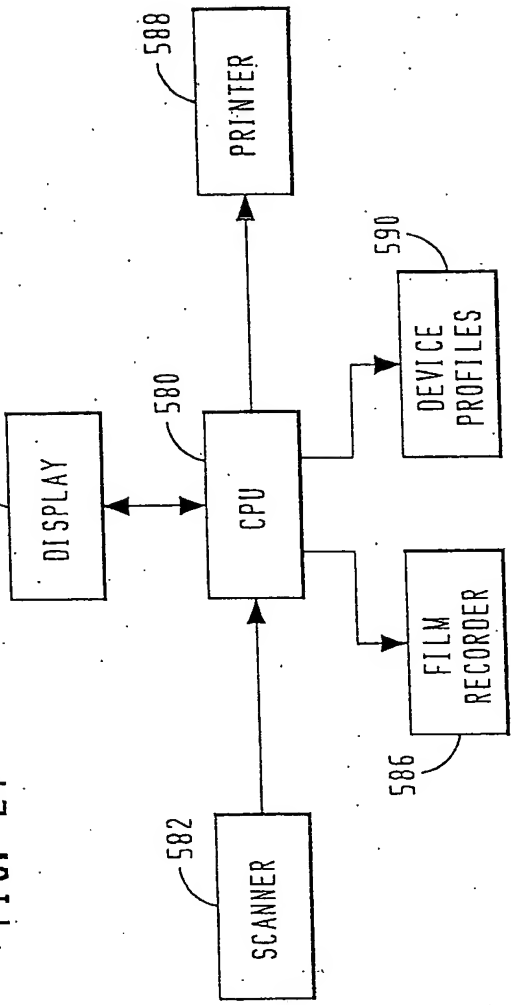


FIG. 25
PRIOR ART

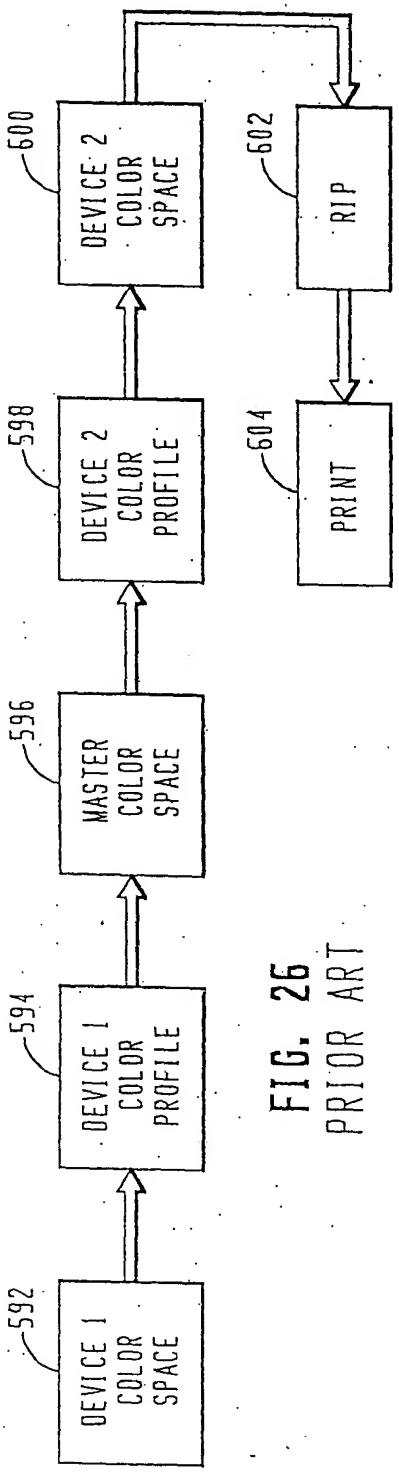


FIG. 26
PRIOR ART

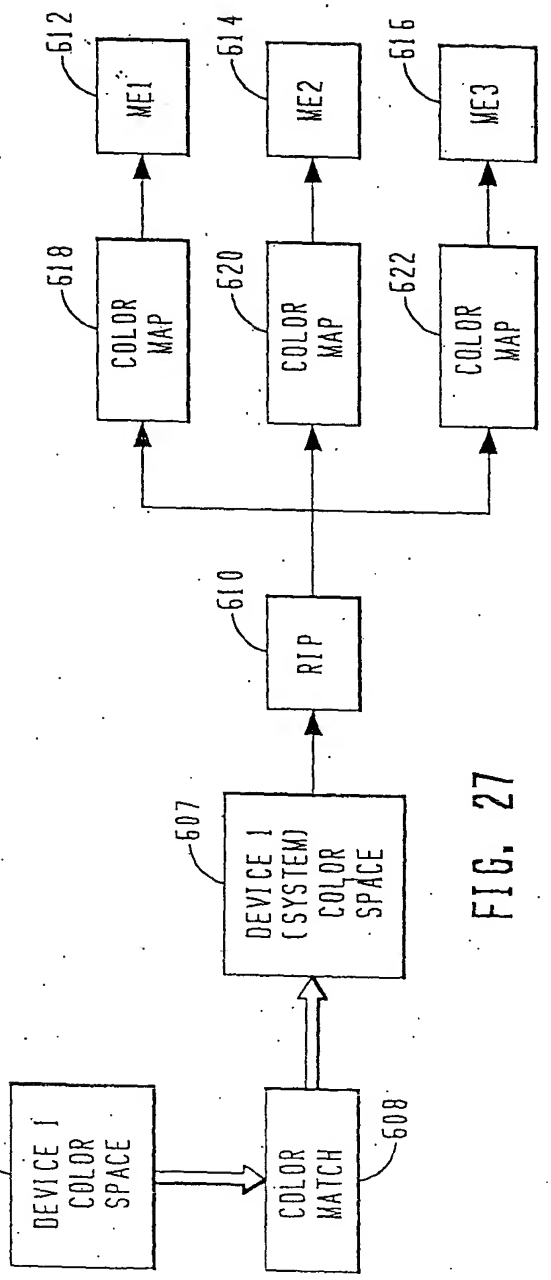


FIG. 27

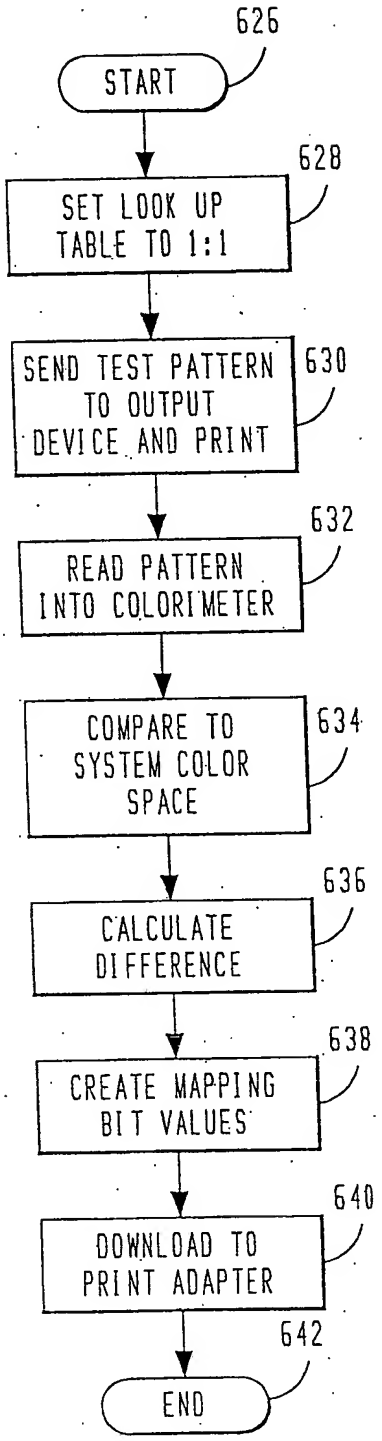

626
START
628
SET LOOK UP TABLE TO 1:1
630
SEND TEST PATTERN TO OUTPUT DEVICE AND PRINT
632
READ PATTERN INTO COLORIMETER
634
COMPARE TO SYSTEM COLOR SPACE
636
CALCULATE DIFFERENCE
638
CREATE MAPPING BIT VALUES
640
DOWNLOAD TO PRINT ADAPTER
642
END

FIG. 28

75% CONTONE	75% CONTONE	75% CONTONE
50% CONTONE	50% CONTONE	50% CONTONE
25% CONTONE	25% CONTONE	25% CONTONE
-2C 0M 0Y	0C 0M 0Y	+2C 0M 0Y

FIG. 28a

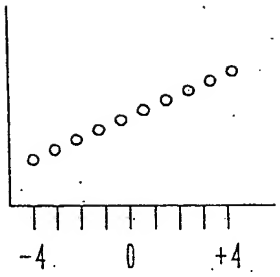


FIG. 28b

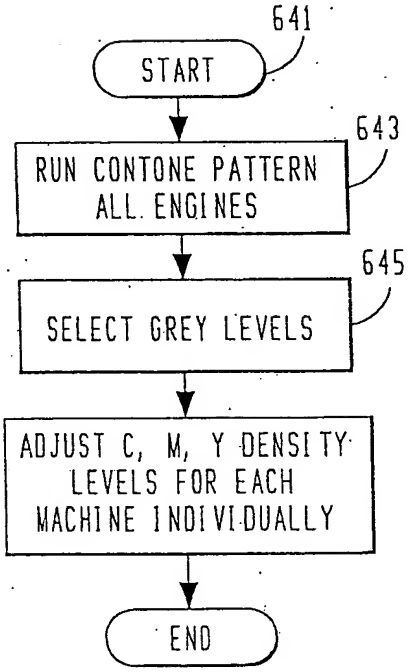


FIG. 28c

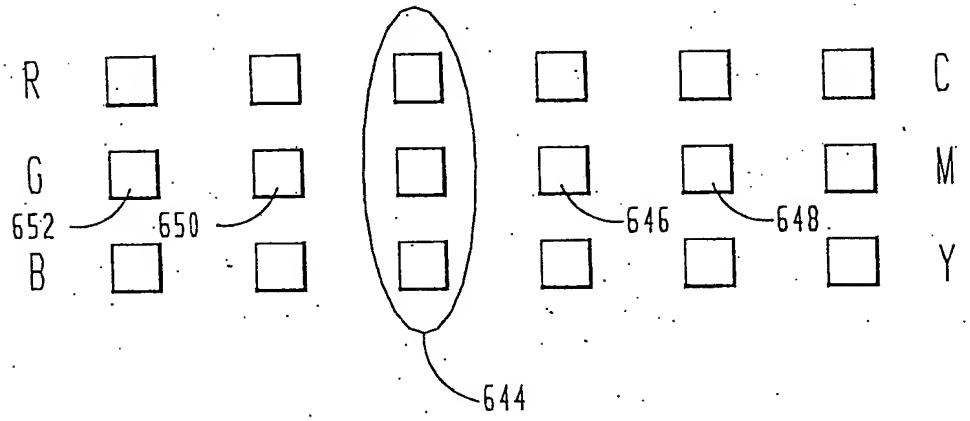

R
G
B
C
M
Y
652
650
646
648
644

FIG. 29

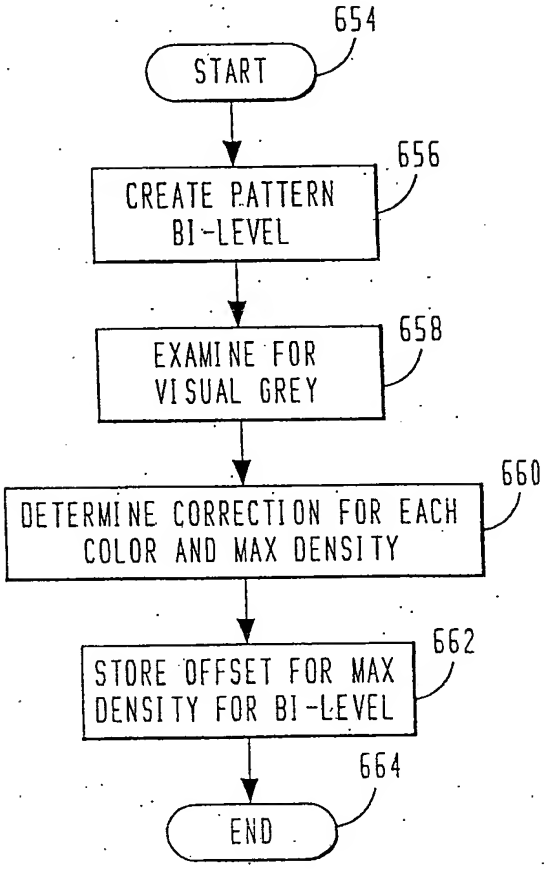

654
START
656
CREATE PATTERN BI-LEVEL
658
EXAMINE FOR VISUAL GREY
660
DETERMINE CORRECTION FOR EACH COLOR AND MAX DENSITY
662
STORE OFFSET FOR MAX DENSITY FOR BI-LEVEL
664
END

FIG. 30

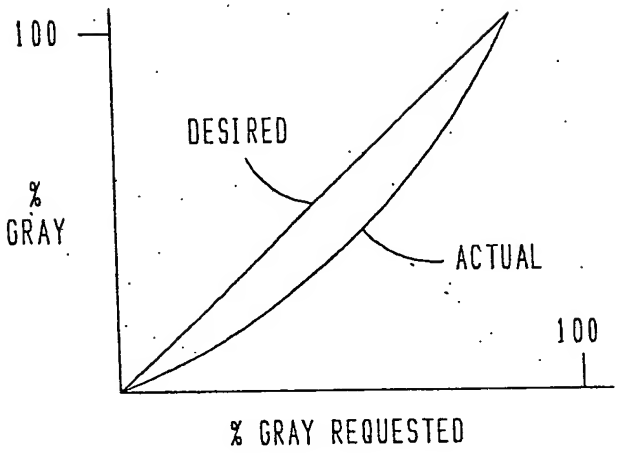

100
DESIRED
% GRAY
ACTUAL
100
% GRAY REQUESTED

FIG. 31

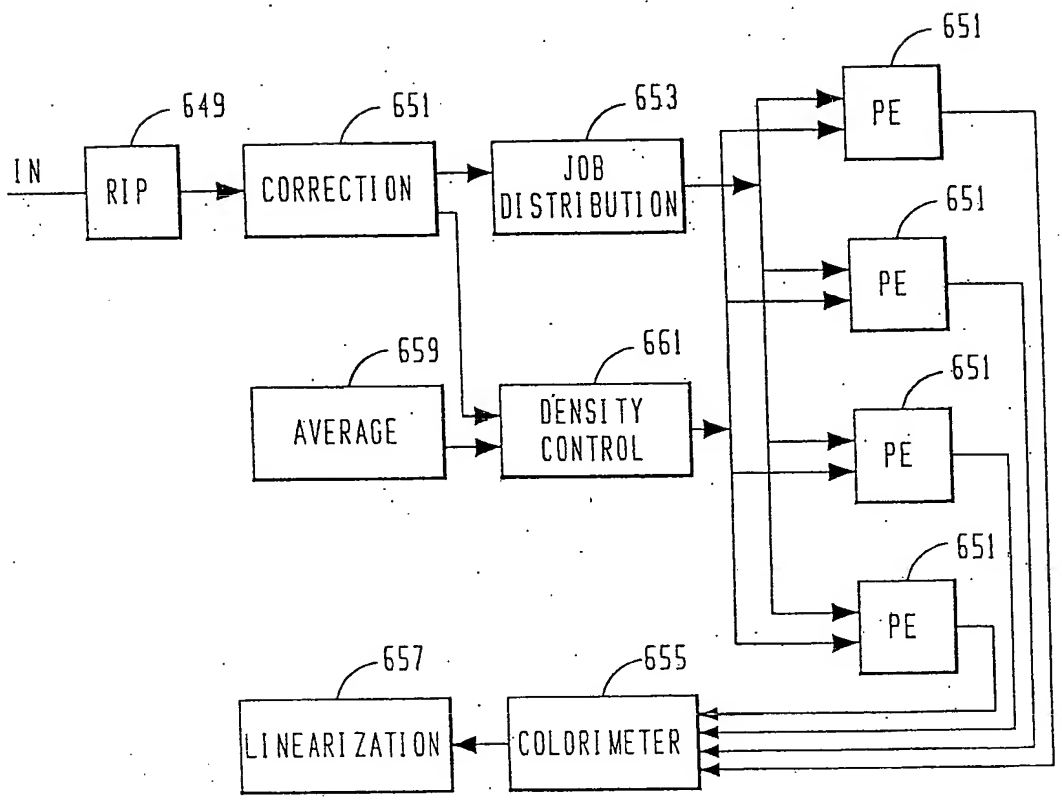

IN
649
RIP
651
CORRECTION
653
JOB DISTRIBUTION
651
PE
651
PE
651
PE
651
PE
659
AVERAGE
661
DENSITY CONTROL
657
LINEARIZATION
655
COLORIMETER

FIG. 32

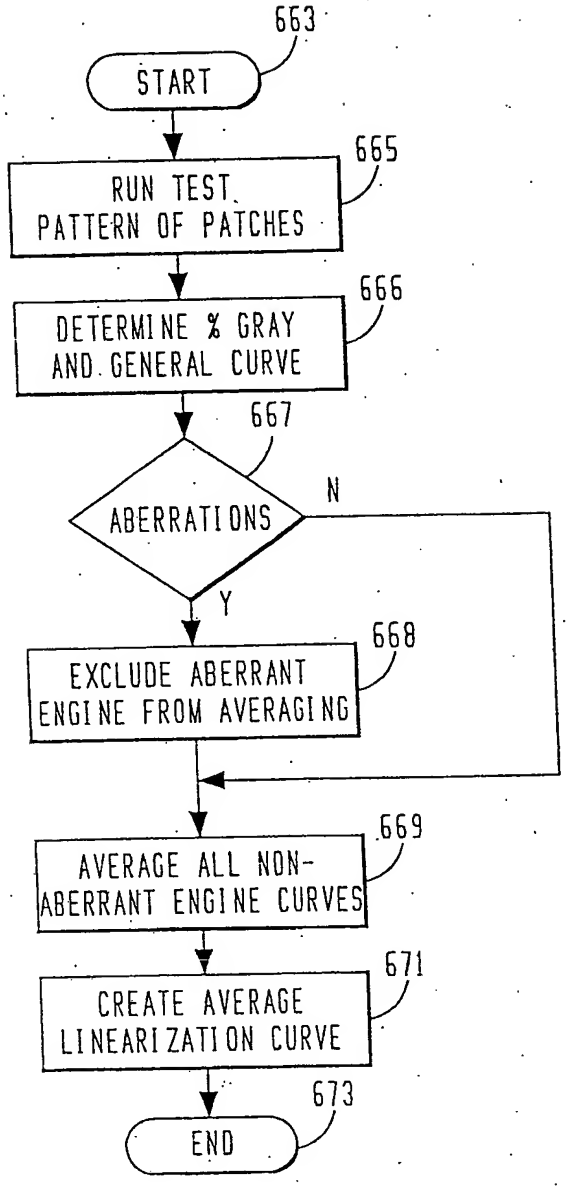

663
START
665
RUN TEST PATTERN OF PATCHES
666
DETERMINE % GRAY AND GENERAL CURVE
667
ABERRATIONS
N
Y
668
EXCLUDE ABERRANT ENGINE FROM AVERAGING
669
AVERAGE ALL NON-ABERRANT ENGINE CURVES
671
CREATE AVERAGE LINEARIZATION CURVE
673
END

FIG. 33

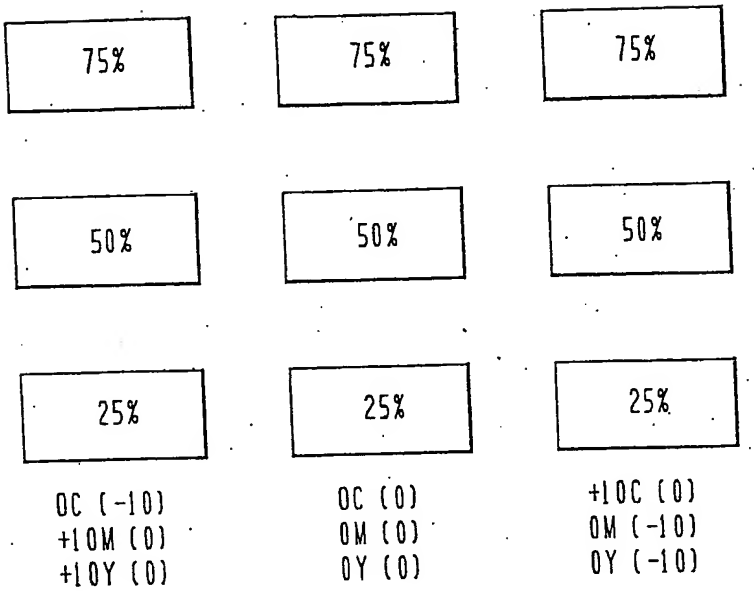


FIG. 29a

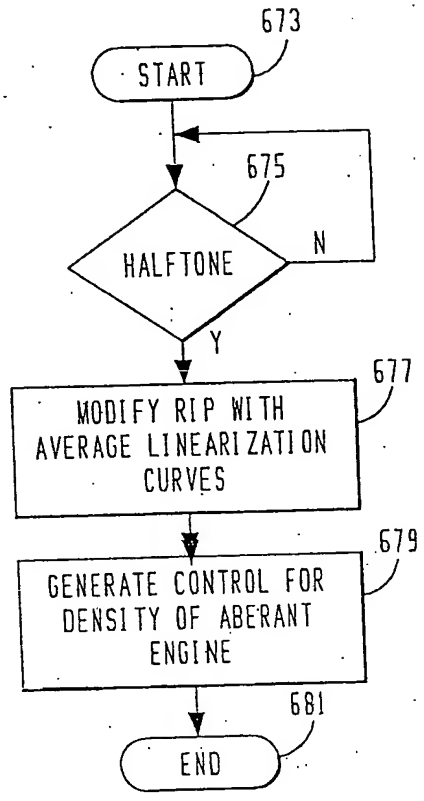


FIG. 34

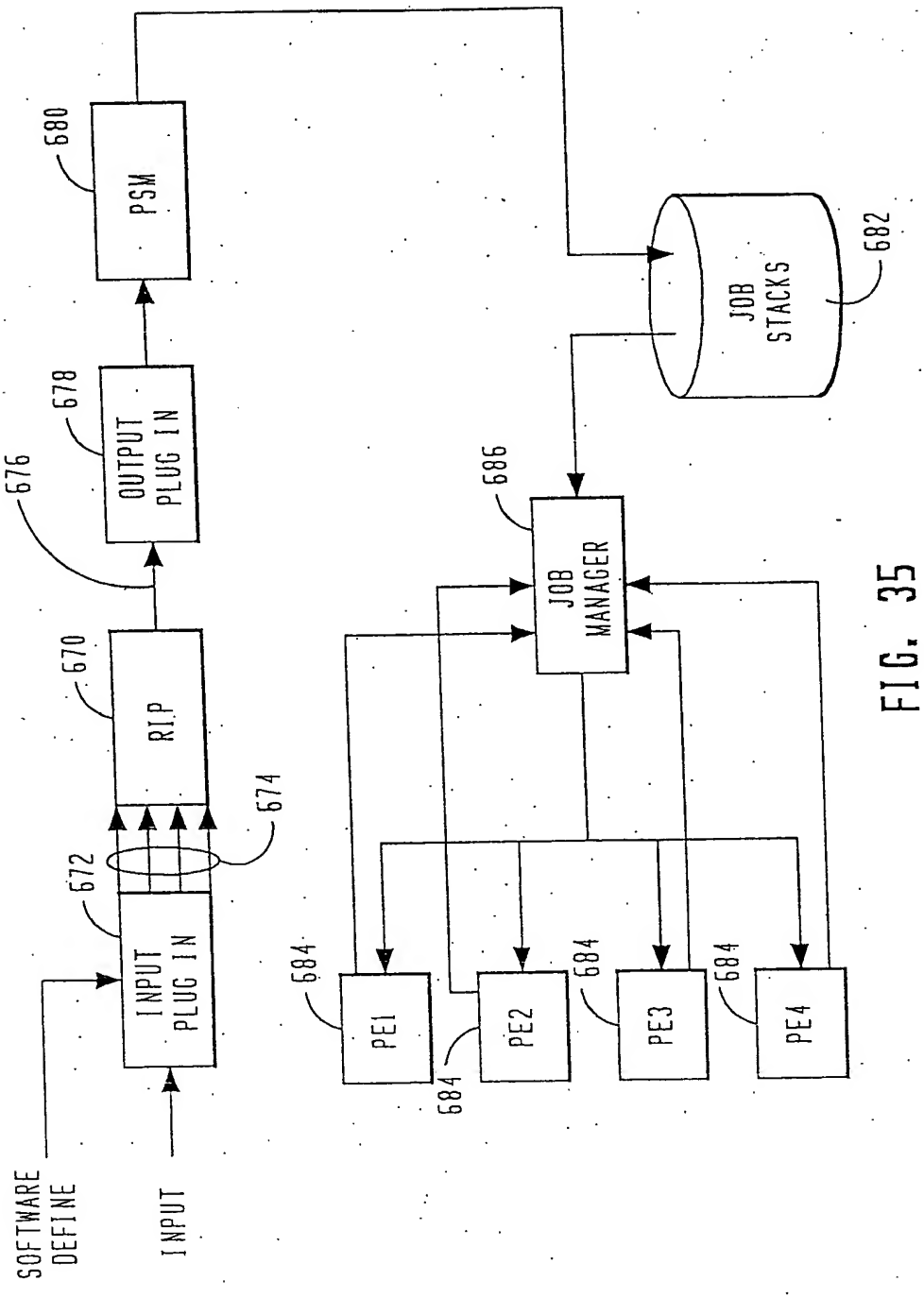

SOFTWARE DEFINE
INPUT
INPUT PLUG IN
672
RIP
670
674
676
OUTPUT PLUG IN
678
PSM
680
JOB STACKS
682
JOB MANAGER
686
PE1
PE2
PE3
PE4
684
684
684
684

FIG. 35

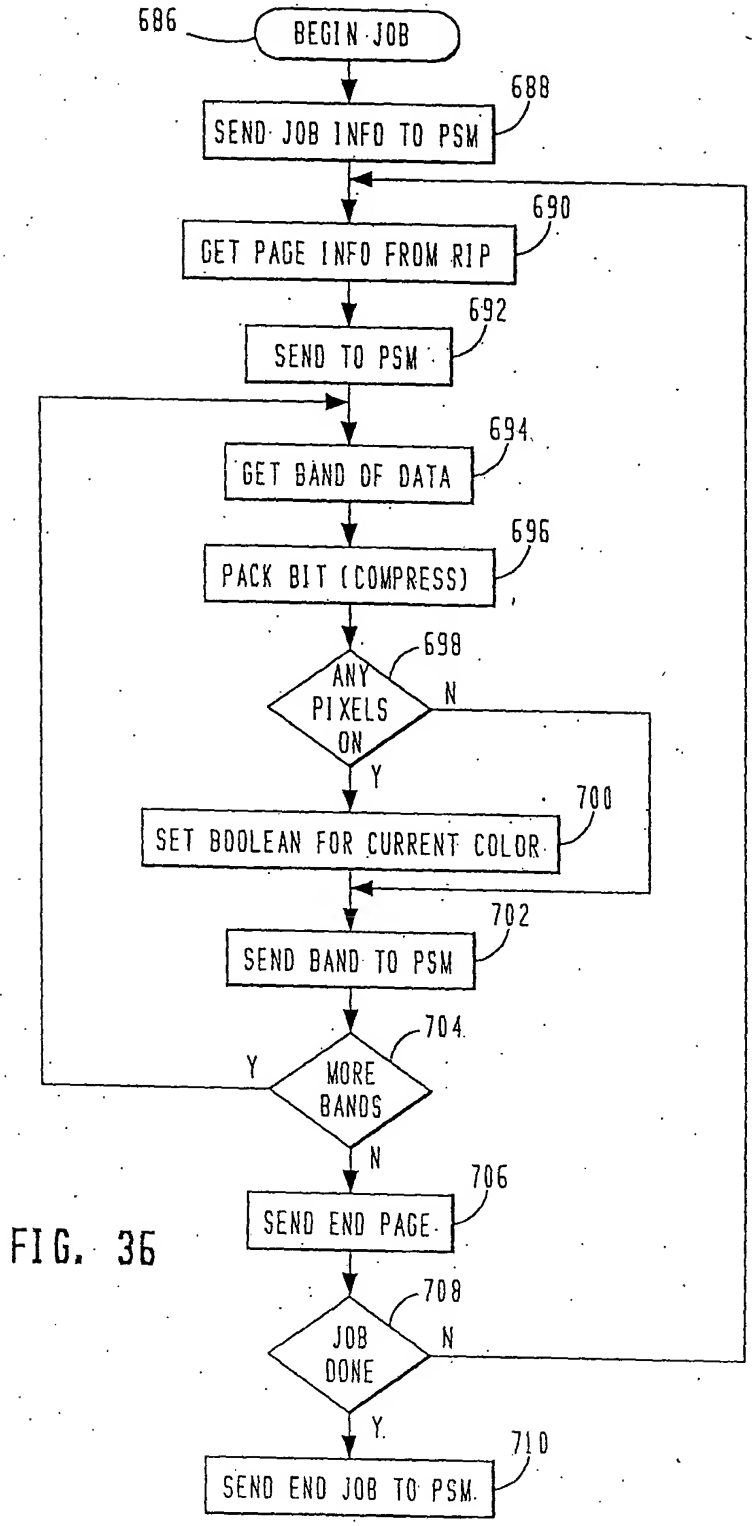

686
BEGIN JOB
688
SEND JOB INFO TO PSM
690
GET PAGE INFO FROM RIP
692
SEND TO PSM
694
GET BAND OF DATA
696
PACK BIT (COMPRESS)
698
ANY PIXELS ON
N
Y
700
SET BOOLEAN FOR CURRENT COLOR
702
SEND BAND TO PSM
704
MORE BANDS
Y
N
706
SEND END PAGE
708
JOB DONE
N
Y
710
SEND END JOB TO PSM

FIG. 36

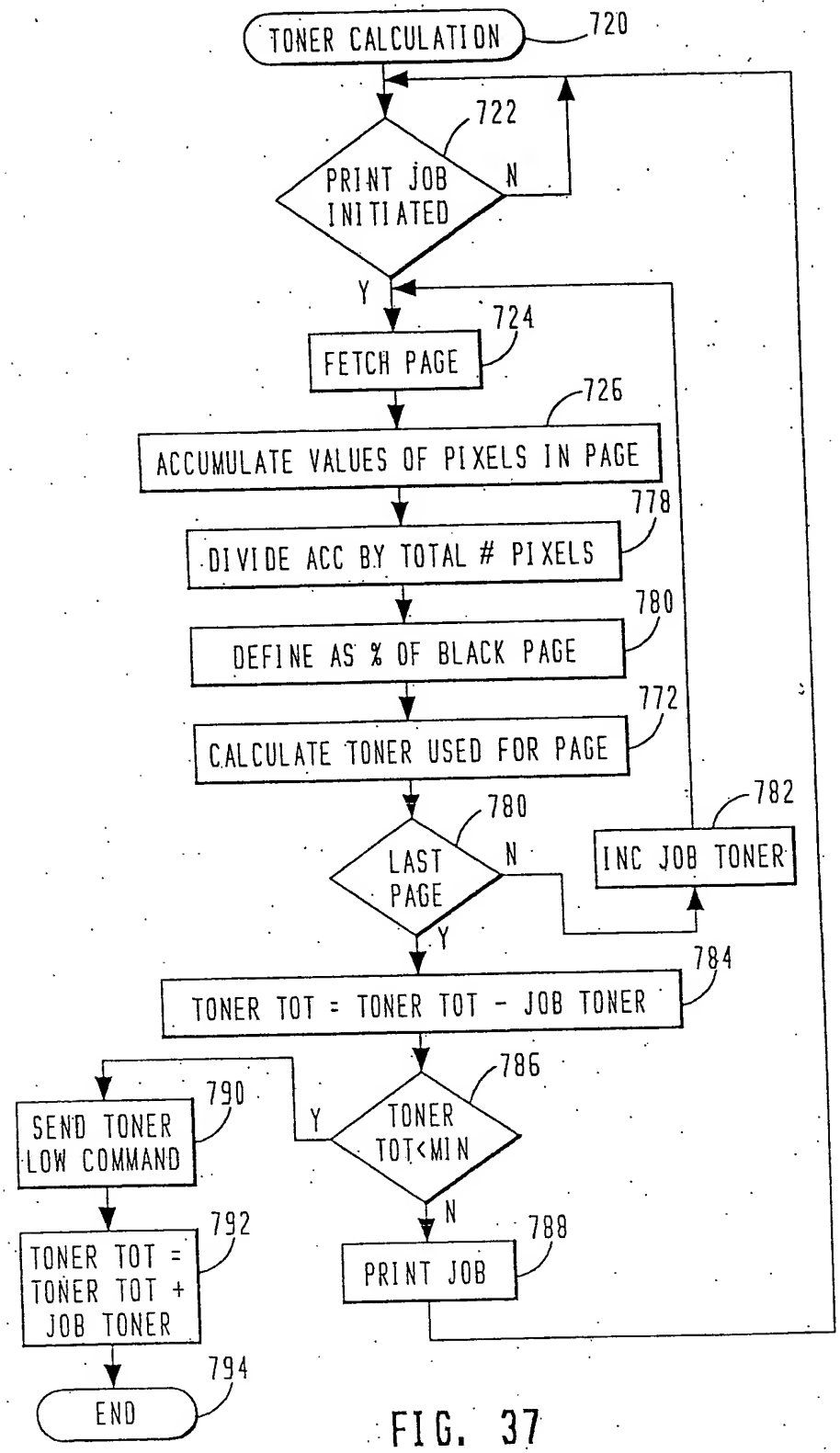

TONER CALCULATION
720
722
PRINT JOB INITIATED
N
Y
724
FETCH PAGE
726
ACCUMULATE VALUES OF PIXELS IN PAGE
778
DIVIDE ACC BY TOTAL # PIXELS
780
DEFINE AS % OF BLACK PAGE
772
CALCULATE TONER USED FOR PAGE
780
LAST PAGE
N
Y
782
INC JOB TONER
784
TONER TOT = TONER TOT - JOB TONER
786
TONER TOT<MIN
Y
N
790
SEND TONER LOW COMMAND
792
TONER TOT = TONER TOT + JOB TONER
788
PRINT JOB
794
END

FIG. 37

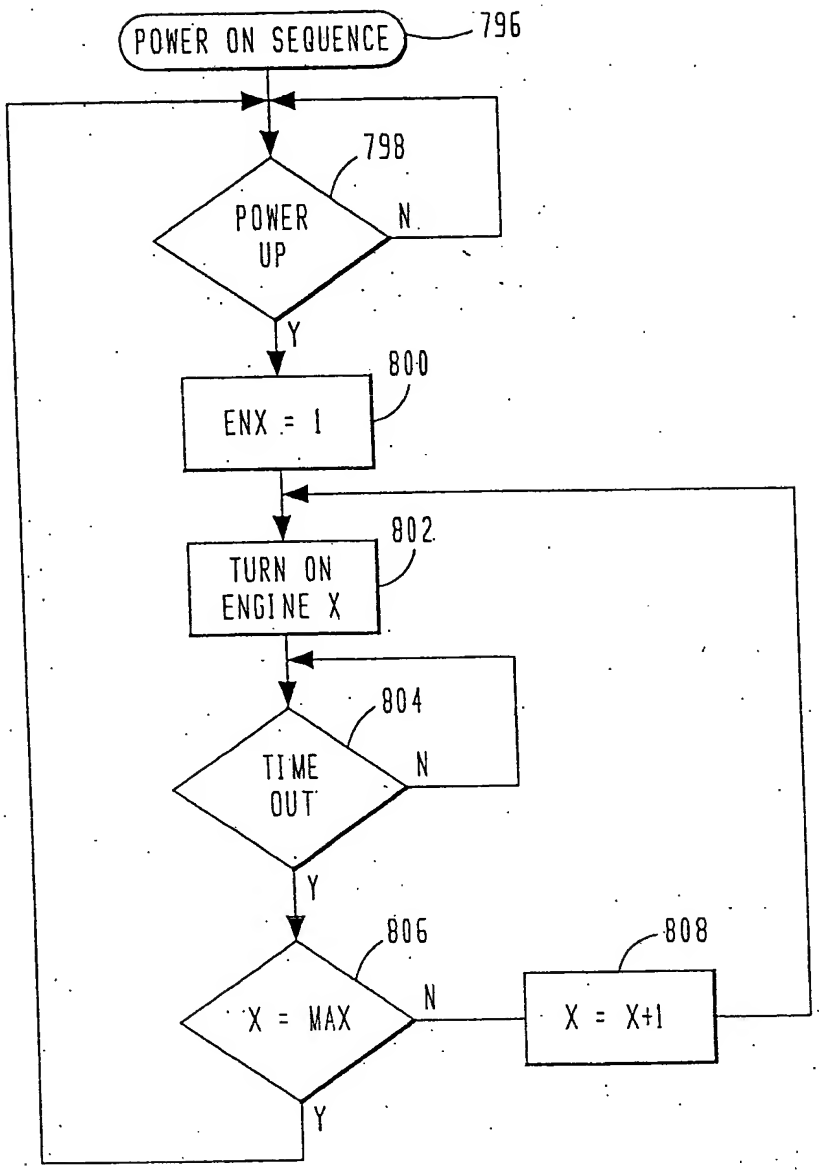

POWER ON SEQUENCE
796
798
POWER UP
N
Y
800
ENX = 1
802
TURN ON ENGINE X
804
TIME OUT
N
Y
806
X = MAX
N
808
X = X+1
Y

FIG. 38

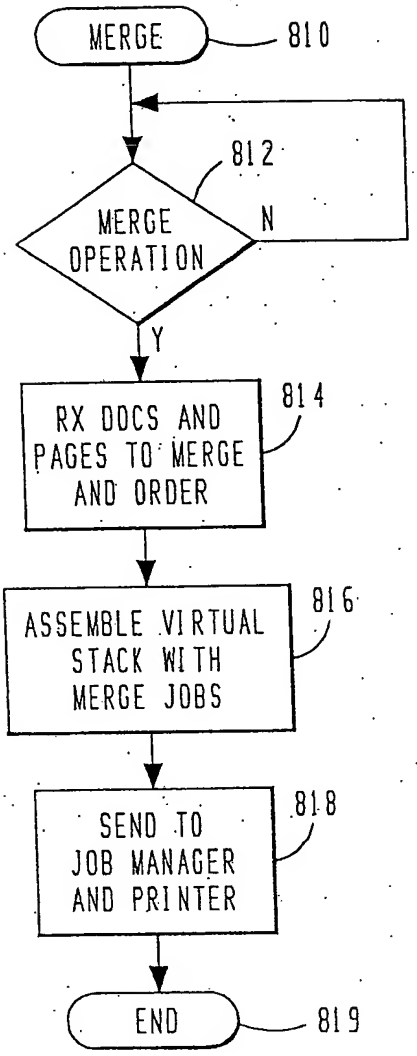

MERGE
810
812
MERGE OPERATION
N
Y
RX DOCS AND PAGES TO MERGE AND ORDER
814
ASSEMBLE VIRTUAL STACK WITH MERGE JOBS
816
SEND TO JOB MANAGER AND PRINTER
818
END
819

FIG. 39

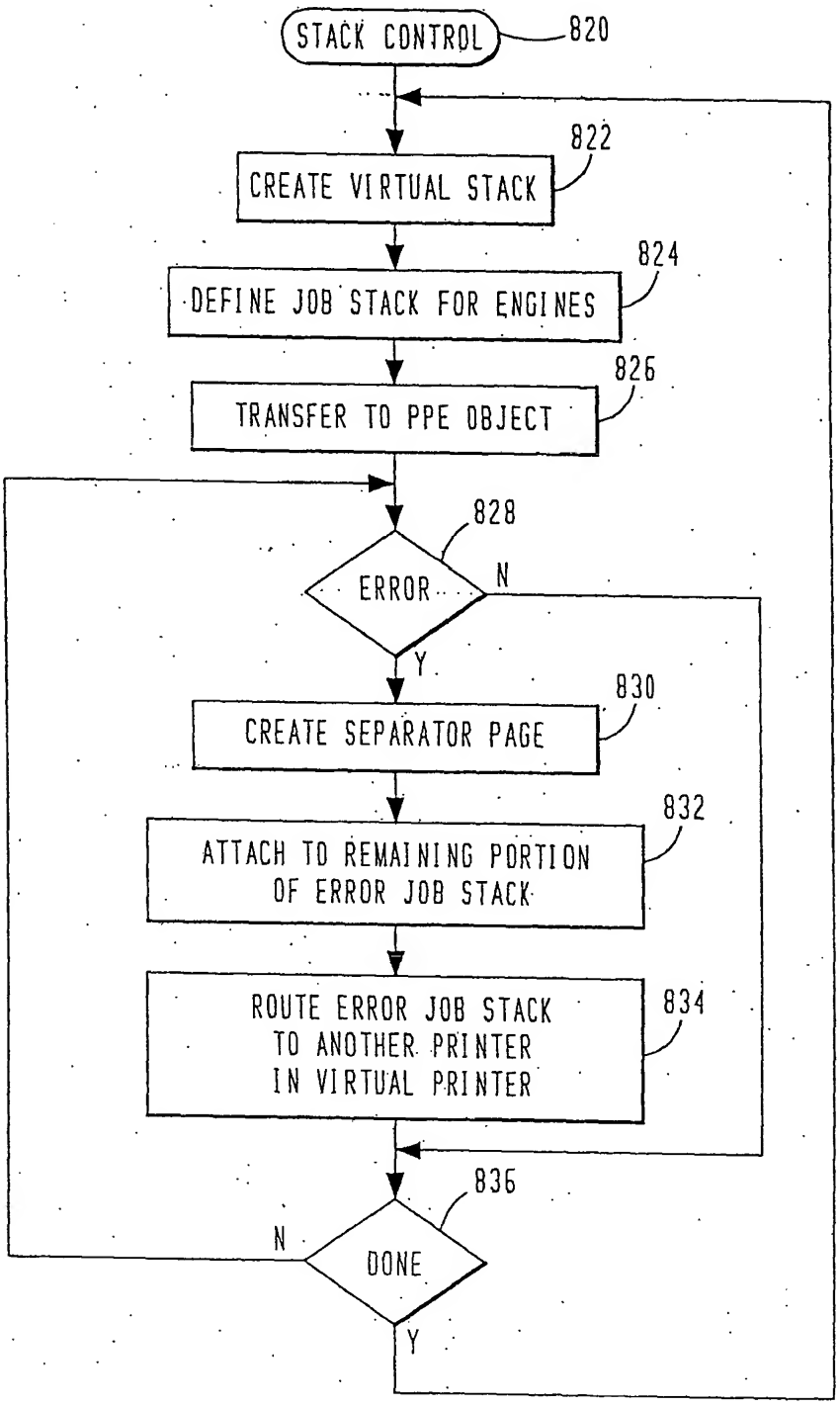

STACK CONTROL
820
CREATE VIRTUAL STACK
822
DEFINE JOB STACK FOR ENGINES
824
TRANSFER TO PPE OBJECT
826
ERROR
828
N
Y
CREATE SEPARATOR PAGE
830
ATTACH TO REMAINING PORTION OF ERROR JOB STACK
832
ROUTE ERROR JOB STACK TO ANOTHER PRINTER IN VIRTUAL PRINTER
834
DONE
836
N
Y

FIG. 40

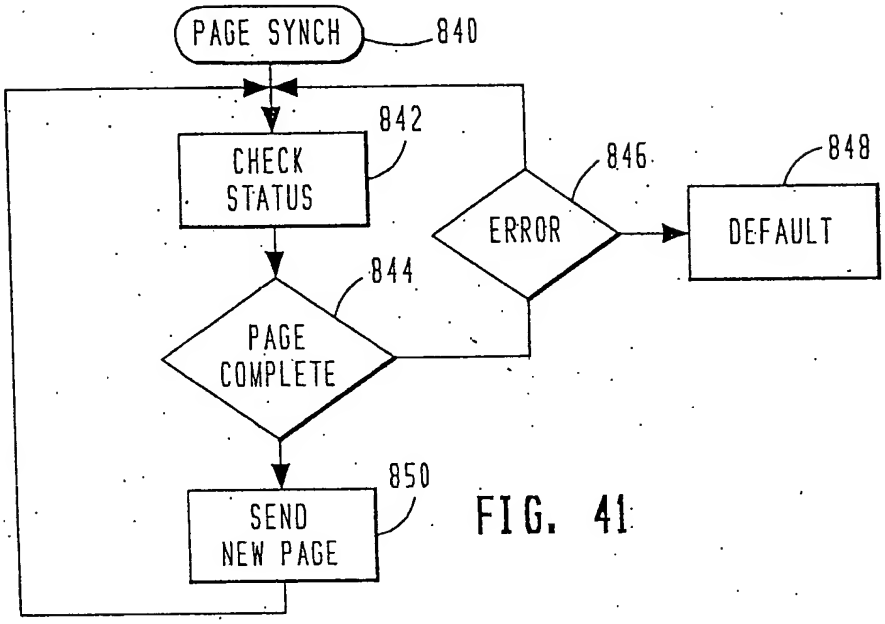

PAGE SYNCH
840
842
CHECK STATUS
846
ERROR
848
DEFAULT
844
PAGE COMPLETE
850
SEND NEW PAGE

FIG. 41

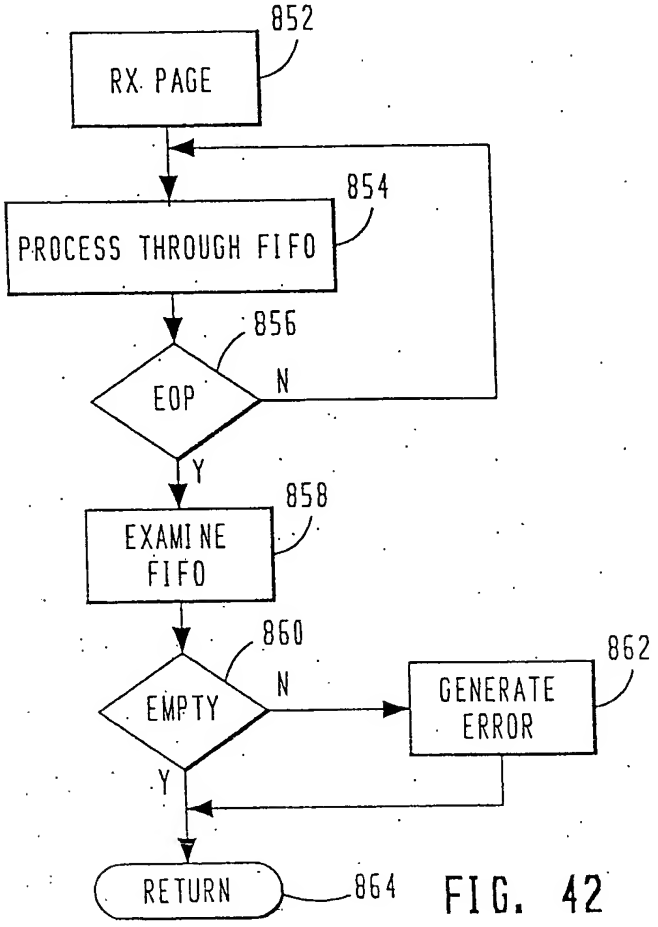

852
RX PAGE
854
PROCESS THROUGH FIFO
856
EOP
N
Y
858
EXAMINE FIFO
860
EMPTY
N
862
GENERATE ERROR
Y
RETURN
864

FIG. 42

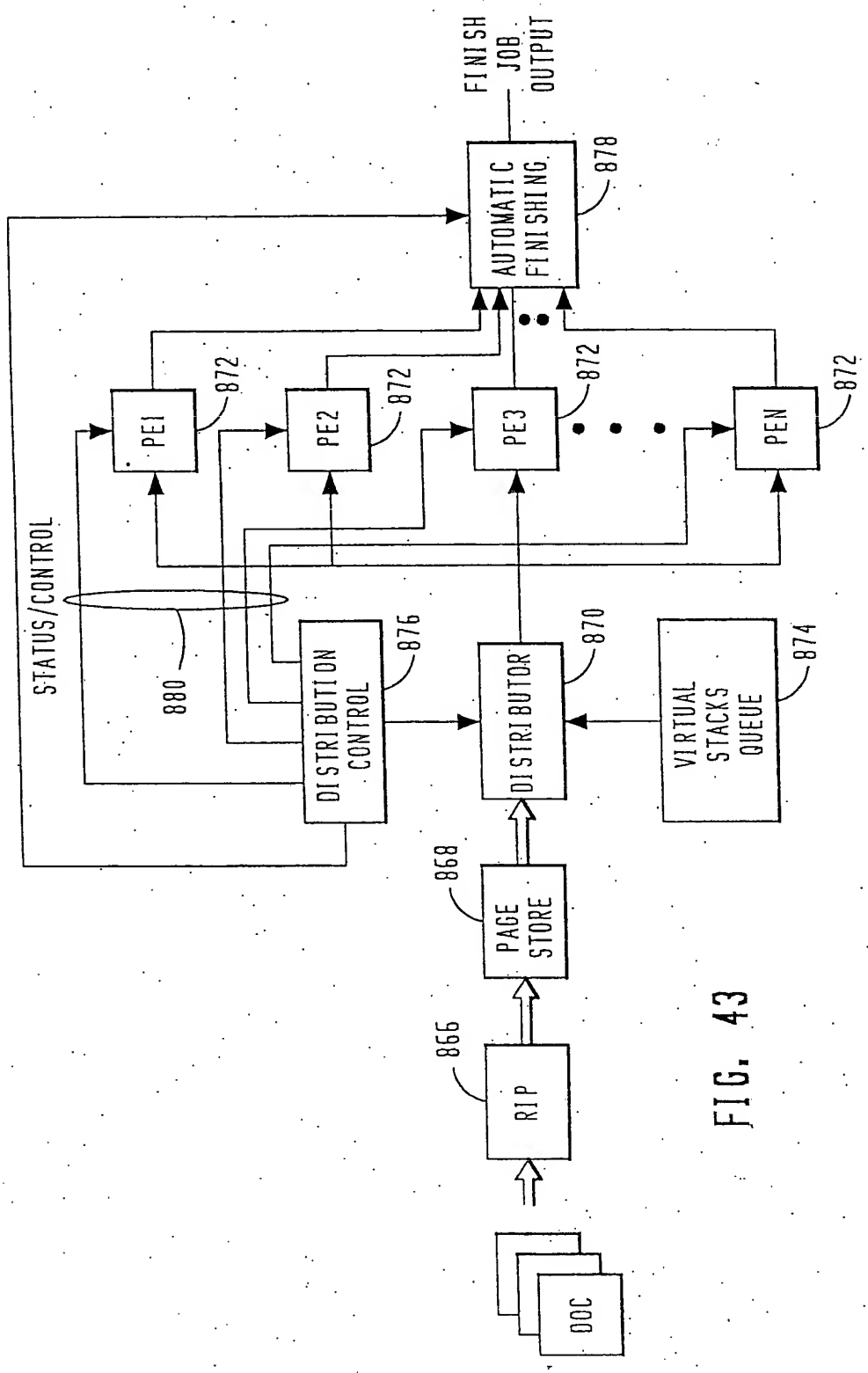

FINISH JOB OUTPUT
AUTOMATIC FINISHING
878
PE1
872
PE2
872
PE3
872
PEN
872
STATUS/CONTROL
880
DISTRIBUTION CONTROL
876
DISTRIBUTOR
870
VIRTUAL STACKS QUEUE
874
PAGE STORE
868
RIP
866
DOC

FIG. 43

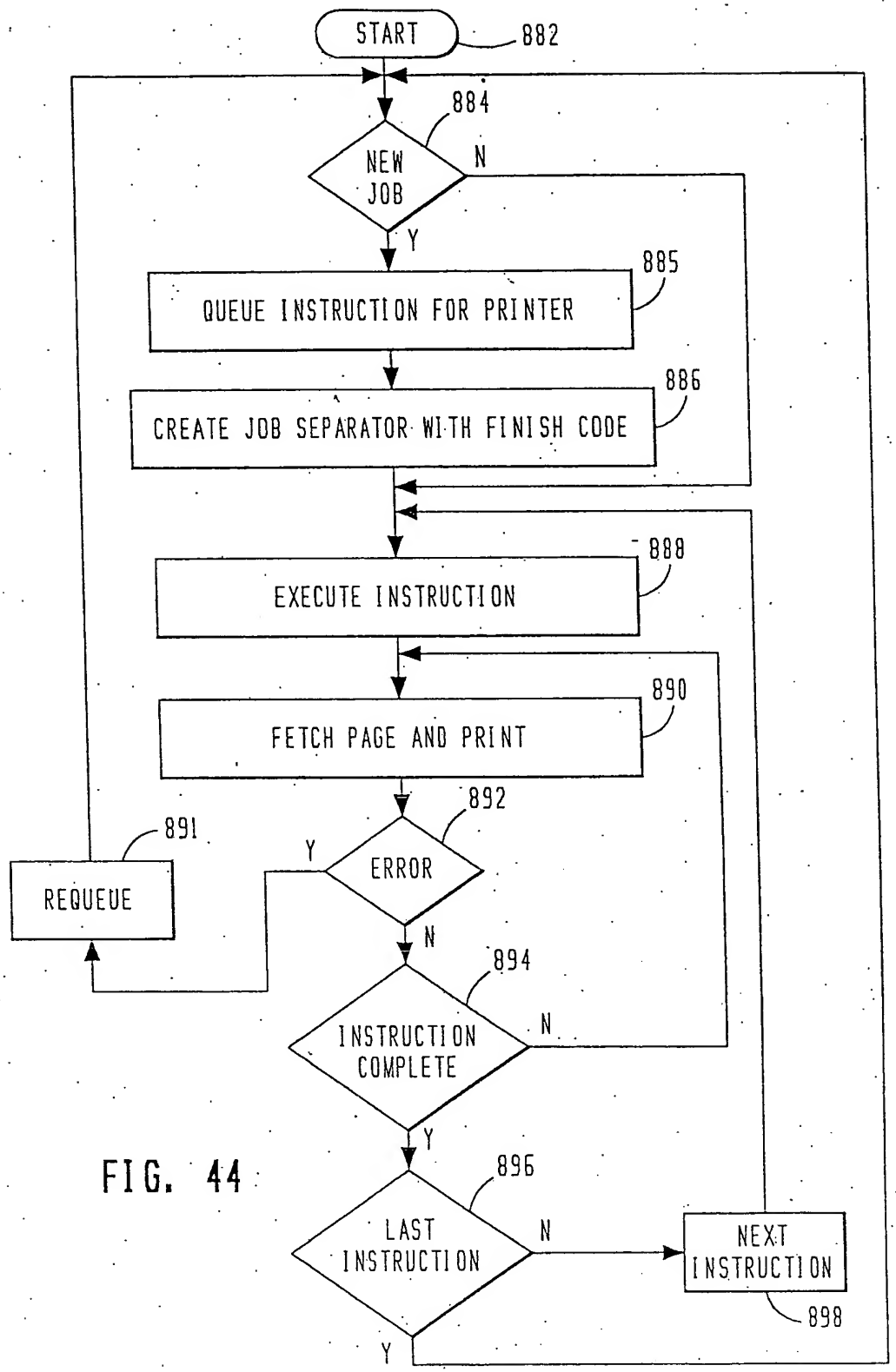

START
882
884
NEW JOB
N
Y
885
QUEUE INSTRUCTION FOR PRINTER
886
CREATE JOB SEPARATOR WITH FINISH CODE
888
EXECUTE INSTRUCTION
890
FETCH PAGE AND PRINT
892
ERROR
891
REQUEUE
Y
N
894
INSTRUCTION COMPLETE
N
Y
896
LAST INSTRUCTION
N
NEXT INSTRUCTION
898
Y

FIG. 44